# Operating Instructions

Diesel engine
12 V 2000 M72
16V 2000 M72

M015650/04E

Power. Passion. Partnership.

Printed in Germany

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

# Commissioning Note

## Important

Please complete and return the “Commissioning Note” card below to MTU Friedrichshafen GmbH.

The Commissioning Note information serves as a basis for the contractually agreed logistic support (warranty, spare parts, etc.).

**Postcard**

**MTU Friedrichshafen GmbH**

**Technical Information Management**

**Dept. VOT**

**88040 Friedrichshafen**

**GERMANY**

| | |
|---|---|
| **Engine No.:** | **MTU works order no.:** |
| **Engine model:** | **Date put into operation:** |
| **Application: *** <br> ☐ Marine ☐ Rail <br> ☐ Genset ☐ ..... | **Type:** <br> **Manufacturer:** |
| **End user`s address:** | |
| **Remarks:** | |

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# 1 Safety

## 1.1 General conditions

### General

In addition to the instructions in this publication, the applicable country-specific legislation and other compulsory regulations regarding accident prevention and environmental protection must be observed. This state-of-the-art engine has been designed to meet all applicable laws and regulations. The engine may nevertheless present a risk of injury or damage in the following cases:

- Incorrect use
- Operation, maintenance and repair by unqualified personnel
- Modifications or conversions
- Noncompliance with the Safety Instructions

### Correct use

The engine is intended solely for use in accordance with contractual agreements and the purpose envisaged for it on delivery. Any other use is considered improper use. The engine manufacturer accepts no liability whatsoever for resultant damage or injury in such case. The responsibility is borne by the user alone.

Correct use also includes observation of and compliance with the maintenance specifications.

### Modifications or conversions

Unauthorized modifications to the engine represent a safety risk.

MTU will accept no liability or warranty claims for any damage caused by unauthorized modifications or conversions.

### Spare parts

Only genuine MTU spare parts must be used to replace components or assemblies. MTU accepts no liability whatsoever for damage or injury resulting from the use of other spare parts and the warranty shall be voided in such case.

### Reworking components

Repair or engine overhaul must be carried out in workshops authorized by MTU.

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## 1.2 Personnel and organizational requirements

### Personnel requirements

Work on the engine must only be carried out by appropriately qualified and instructed personnel.

Observe the minimum legal age.

Responsibilities of the operating, maintenance and repair personnel must be specified by the operating company.

### Organizational measures

This publication must be issued to all personnel involved in operation, maintenance, repair or transportation.

Keep it handy in the vicinity of the engine such that it is accessible to operating, maintenance, repair and transport personnel at all times.

Use the manual as a basis for instructing personnel on engine operation and repair. In particular, personnel must have read and understood the safety-relevant instructions.

This is especially important for personnel who work on the engine only on an occasional basis. These persons shall receive repeated instruction.

Use the Spare Parts Catalog to identify spare parts during maintenance and repair work.

### Working clothes and protective equipment

Wear proper protective clothing for all work.

Depending on the kind of work, use the necessary personal protective equipment.

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## 1.3 Transport

### Transport

Only use the lifting eyes provided to lift the engine.

Only use transport and lifting devices approved by MTU.

Take the engine's center of gravity into account.

The engine must only be transported in installation position, max. permissible diagonal pull 10°.

If the engine is supplied with special aluminum foil packing, lift the engine at the lifting eyes of the bearing pedestal or use a means of transportation which is appropriate for the given weight (forklift truck).

Install the crankshaft locking device and the locking screws for the engine mounts prior to engine transportation.

Secure the engine against tilting during transport. In particular when going down inclines or ramps, the engine must be secured against moving and tilting.

### Setting the engine down after transport

Only set down engine on a firm, level surface.

Make sure that the consistency and load-bearing capacity of the ground or support surface is adequate.

Never set an engine down on the oil pan unless expressively authorized to do so by MTU on a case-to-case basis.

TIM-ID: 0000002614 - 003

## 1.4 Safety regulations for startup and operation

### Safety requirements for initial operation

Prior to initial operation of the unit, install the assembly or unit according to the specifications and check the installation according to the MTU specifications.

Before putting the device or plant into operation, always ensure:
- that all maintenance and repair work is completed,
- that all loose parts have been removed from rotating machine components,
- that nobody is in the danger area of moving machine parts.

Immediately after putting the device or plant into operation, make sure that all control and display instruments as well as the signaling and alarm systems work properly.

### Safety requirements for operators

The procedures for cases of emergency must be practiced regularly.

The operator must be familiar with the control and display elements.

The operator must be familiar with the consequences of any operations performed.

During operation, the display instruments and monitoring units must be permanently observed with regard to present operating status, violation of limit values and warning or alarm messages.

The following steps must be taken if a malfunction of the system is recognized or reported by the system:
- inform supervisor(s) in charge,
- analyze the message,
- if required, carry out emergency operations e.g. emergency engine stop.

### Engine operation

The following conditions must be fulfilled before starting the engine:
- Wear ear protection.
- Ensure that the engine room is well ventilated.
- Do not inhale engine exhaust gases.
- Ensure that the exhaust system is free of leaks and that the gases are discharged to atmosphere.
- Mop up any leaked or spilt fluids and lubricants immediately or soak up with a suitable binding agent.
- Protect battery terminals, battery-charger terminals and cables against accidental contact.
- When the engine is running, never release coolant, oil, fuel, compressed-air or hydraulic lines.

### Operation of electrical equipment

When electrical equipment is in operation, certain components of these appliances are electrically live.

Observe the safety instructions for these devices.

TIM-ID: 0000023743 - 009

# 1.5 Safety regulations for maintenance and repair work

## Safety regulations for maintenance and repair work

Have maintenance and repair work carried out by qualified and authorized personnel only.

Allow the engine to cool down before starting maintenance work (risk of explosion of oil vapors).

Before starting work, relieve pressure in systems and compressed-air lines which are to be opened.

Take special care when removing ventilation or plug screws from the engine. Cover the screw or plug with a rag to prevent fluids escaping under pressure.

Take special care when draining hot fluids ⇒ Risk of injury.

When changing the engine oil or working on the fuel system, ensure that the engine room is adequately ventilated.

Allow the engine / system to cool down before starting to work.

Observe the maintenance and repair instructions.

Never carry out maintenance and repair work with the engine running unless expressly instructed to do so.

Secure the engine against accidental starting.

Disconnect the battery when electrical starters are fitted.

Close the main valve on the compressed-air system and vent the compressed-air line when pneumatic starters are fitted.

Disconnect the control equipment from the assembly or system.

Use only proper, calibrated tools. Observe the specified tightening torques during assembly/disassembly.

Carry out work only on assembles and/or units which are properly secured.

Never use lines for climbing.

Keep fuel injection lines and connections clean.

Always seal connections with caps or covers if a line is removed or opened.

Take care not to damage lines, in particular fuel lines, during maintenance and repair work.

Ensure that all retainers and dampers are installed correctly.

Ensure that all fuel injection and pressurized oil lines are installed with enough clearance to prevent contact with other components. Do not place fuel or oil lines near hot components.

Do not touch elastomeric seals if they have carbonized or resinous appearance unless hands are properly protected.

Note cooling time for components which are heated for installation or removal ⇒ Risk of burning.

When working high on the engine, always use suitable ladders and work platforms. Make sure components are placed on stable surfaces.

Observe special cleanness when conducting maintenance and repair work on the assembly or system. After completion of maintenance and repair work, make sure that no loose objects are in/on the assembly or system.

Before barring the engine, make sure that nobody is standing in the danger zone. Check that all guards have been reinstalled and that all tools and loose parts have been removed after working on the engine.

The following additional instructions apply to starters with beryllium copper pinion:

- Breathing protection of filter class P2 must be applied during maintenance work to avoid health hazards caused by the beryllium-containing pinion. Do not blow out the interior of the flywheel housing or the starter with compressed air. Clean the flywheel housing inside with a class H dust extraction device as an additional measure.

TIM-ID: 0000000879 - 023

## Welding work

Never carry out welding work on the assembly, system, or engine-mounted units. Cover the engine when welding in its vicinity.

Do not use the assembly or system as ground terminal.

Do not route the welding lead over or near the wiring harnesses of MTU systems. The welding current may otherwise induce an interference voltage in the wiring harnesses which could conceivably damage the electrical system.

Remove parts (e.g. exhaust pipes) which are to be welded from the engine beforehand.

## Hydraulic installation and removal

Check the function and safe operating condition of tools and fixtures to be used. Use only the specified devices for hydraulic removal/installation procedures.

Observe the max. permissible push-on pressure specified for the equipment.

Do not attempt to bend or apply force to lines.

Before starting work, pay attention to the following:
- Vent the hydraulic installation/removal tool, the pumps and the lines at the relevant points for the equipment to be used (e.g. open vent plugs, pump until bubble-free air emerges, close vent plugs).
- For hydraulic installation, screw on the tool with the piston retracted.
- For hydraulic removal, screw on the tool with the piston extended.

For a hydraulic installation/removal tool with central expansion pressure supply, screw spindle into shaft end until correct sealing is established.

During hydraulic installation and removal, ensure that nobody is standing in the immediate vicinity of the component to be installed/removed.

## Working on electrical/electronic assemblies

Always obtain the permission of the person in charge before commencing maintenance and repair work or switching off any part of the electronic system required to do so.

De-energize the appropriate areas prior to working on assemblies.

Do not damage cabling during removal work. When reinstalling ensure that wiring is not damaged during operation by contact with sharp objects, by rubbing against other components or by a hot surface.

Do not secure cables on lines carrying fluids.

Do not use cable binders to secure cables.

Always use connector pliers to tighten connectors.

Subject the device or system to a function check on completion of all repair work.

Store spare parts properly prior to replacement, i.e. protect them against moisture in particular. Pack defective electronic components and assemblies in a suitable manner when dispatched for repair, i.e. particularly protected against moisture and impact and wrapped in antistatic foil if necessary.

## Working with laser equipment

When working with laser equipment, always wear special laser-protection goggles ⇒ Heavily focused radiation.

Laser equipment must be fitted with the protective devices necessary for safe operation according to type and application.

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For conducting light-beam procedures and measurement work, only the following laser devices must be used:

- Laser devices of classes 1, 2 or 3A.
- Laser devices of class 3B, which have maximum output in the visible wavelength range (400 to 700 nm), a maximum output of 5 mW, and in which the beam axis and surface are designed to prevent any risk to the eyes.

TIM-ID: 0000000879 - 023

# 1.6 Auxiliary materials, fire prevention and environmental protection

## Fire prevention

Rectify any fuel or oil leaks immediately; even splashes of oil or fuel on hot components can cause fires - therefore always keep the engine in a clean condition. Do not leave cloths soaked with fluids and lubricants lying around on the engine. Do not store combustible fluids near the engine.

Do not weld pipes and components carrying oil or fuel. Before welding, clean with a non-combustible fluid.

When starting the engine with a foreign power source, connect the ground lead last and remove it first. To avoid sparks in the vicinity of the battery, connect the ground lead from the foreign power source to the ground lead of the engine or to the ground terminal of the starter.

Always keep suitable fire-fighting equipment (fire extinguishers) at hand and familiarize yourself with their use.

## SOLAS classification

On engines/plants with SOLAS classification, operational checks must include the following tasks:
- Check all covers (fitted in accordance with SOLAS requirements) on lube oil and fuel pipe connections (>1.8 bar) for damage, replace as necessary. (→ Page 19)

## Noise

Noise can lead to an increased risk of accident if acoustic signals, warning shouts or noises indicating danger are drowned.

At all workplaces with a sound pressure level over 85 dB(A), always wear ear protectors (protective wadding, plugs or capsules).

## Environmental protection

Modification or removal of mechanical or electronic components or the installation of additional components as well as the execution of calibration processes that might affect the emission characteristics of the engine are prohibited by emission regulations. Emission control units/systems may only be maintained, exchanged or repaired if the components used for this purpose are approved by MTU or equivalent components. Noncompliance with these guidelines might represent a violation of the Clean Air Act and could involve the termination of the operating license by the emission authorities. MTU does not accept any liability for violations of the emission regulations. MTU will provide assistance and advice if emission-relevant components are intended to be modified. The MTU Maintenance Schedules ensure the reliability and performance of MTU engines and must be complied with over the entire life cycle of the engine.

Only fuels of the specified quality required to achieve emission limits must be used.

In Germany, the VAwS (=regulations governing the use of plants that may affect water quality) is applicable, which means work must only be carried out by authorized specialist companies (MTU is an authorized specialist company).

Dispose of used fluids, lubricants and filters in accordance with local regulations.

## Auxiliary materials

Use only fluids and lubricants that have been tested and approved by MTU.

Fluids and lubricants must be kept in suitable, properly designated containers. When using fluids, lubricants and other chemical substances, follow the safety instructions applicable to the product. Take care when handling hot, chilled or caustic materials. When using inflammable materials, avoid sparks and do not smoke.

TIM-ID: 0000002828 - 004

## Lead

- When working with lead or lead-containing pastes, avoid direct contact with the skin and do not inhale lead vapors.
- Adopt suitable measures to avoid the formation of lead dust!
- Switch on fume extraction system.
- After coming into contact with lead or lead-containing materials, wash hands!

## Acids and alkaline solutions

- When working with acids and alkalis, wear protective goggles or face mask, gloves and protective clothing.
- Immediately remove clothing wetted by acids and alkalis!
- Rinse injuries with plenty of water!
- Rinse eyes immediately with eyedrops or clean tap water.

## Painting

- When painting in other than spray booths equipped with extractors, ensure good ventilation. Make sure that adjacent work areas are not affected.
- No naked flames!
- No smoking.
- Observe fire prevention regulations!
- It is absolutely necessary to wear masks providing protection against paint and solvent fumes.

## Liquid nitrogen

- Store liquid nitrogen only in small quantities and always in regulation containers without fixed covers.
- Do not bring liquid nitrogen in contact with the body (eyes, hands), as this causes frostbite and numbing.
- Wear protective clothing, gloves, closed shoes and protective goggles!
- Ensure the room is well ventilated. 88% contamination of breathing air with nitrogen will result in suffocation.
- Avoid all knocks and jars to the containers, fixtures or workpieces.

## Compressed air

Compressed air is air compressed at excess pressure and is stored in tanks from which it can be extracted.

The pressure at which the air is kept can be read off at pressure gauges which must be connected to the compressed air tanks and the compressed air lines.

When working with compressed air, safety precautions must be constantly observed:

- Pay special attention to the pressure level in the compressed air network and pressure vessel!
- Connecting devices and equipment must either be designed for this pressure or, if the permitted pressure for the connecting elements is lower than the pressure required, a pressure reducing valve and safety valve (set to permitted pressure) must form an intermediate connection. Hose coupling and connections must be securely attached!
- Always wear protective goggles when blowing off tools or extracting chips!
- The snout of the air nozzle is provided with a protective disc (e.g. rubber disc), which prevents airborne particles being reflected and thereby prevents injury to eyes.
- First shut off compressed air lines before compressed air equipment is disconnected from the supply line or before equipment or tool is to be replaced!
- Unauthorized use of compressed air, e.g. forcing flammable liquids (danger class AI, AII and B) out of containers, results in a risk of explosion!
- Forcing compressed air into thin-walled containers (e.g. sheet metal, plastic, glass) for drying purposes or to check for leaks will result in a risk of bursting!
- Do not blow dirty clothing with compressed air when being worn on the body.

TIM-ID: 0000002828 - 004

## Used oil

Used oil may contain health-threatening combustion residues.

Rub barrier cream into hands! Wash hands after contact with used oil.

TIM-ID: 000000828 - 004

## 1.7 Conventions for safety instructions in the text

| | |
|---|---|
| DANGER | In the event of immediate danger.<br>**Consequences: Death or serious injury**<br>• Remedial action |
| WARNING | In the event of potentially dangerous situations.<br>**Consequences: Death or serious injury**<br>• Remedial action |
| CAUTION | In the event of dangerous situations.<br>**Consequences: Minor injury or material damage**<br>• Remedial action |
| NOTICE | In the event of a situation involving potentially adverse effects on the product.<br>**Consequences: Material damage.**<br>• Remedial action<br>• Additional product information |

Note: This manual contains highlighted safety warnings in accordance with the US ANSI Z535 standard which begin with one of the signal words listed above depending on the severity of the hazard.

### Safety instructions

1. Read and familiarize yourself with all safety notices before starting up or repairing the product.
2. Pass on all safety instructions to your operating, maintenance, repair and transport personnel.

TIM-ID: 0000000881 - 017

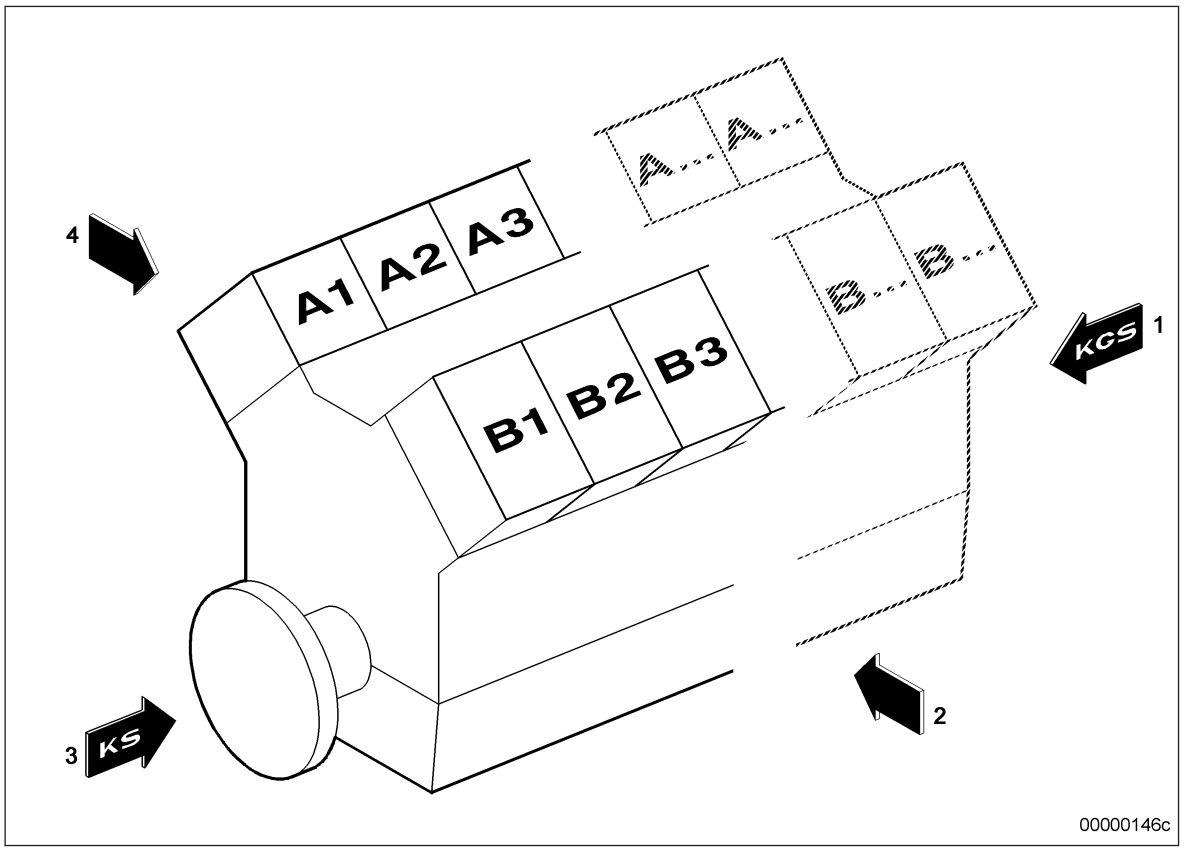
# 2 General Information

## 2.1 Engine side and cylinder designations

Engine sides are always designated as viewed from the driving end (KS).

The cylinders of the left engine side are designated "A" and those of the right side "B" (as per DIN ISO 1204). The cylinders of each bank are numbered consecutively, starting with No. 1 at the driving end of the engine.

Other components are numbered in the same way, i.e. starting with No. 1 on driving end.




1 KGS = Free end
2 Right engine side
3 KS = Driving end
4 Left engine side

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# 2.2 Product description

## Description of the engine

### Engine

The engine is a liquid-cooled four-stroke diesel engine with c.c.w. direction of rotation, direct injection, sequential turbocharging and charge-air cooling.

An electronic management system provides engine control and monitoring.

### Fuel system with common rail injection

Controlled by the engine electronics, the common rail injection system determines injection pressure, injection timing and injection quantity independently of the engine speed.

Injection pressures up to 1800 bar ensure optimum fuel injection and combustion conditions.

### Charging system

The charging system comprises charge-air system, exhaust system and sequential turbocharging.

The exhaust system is equipped with triple-walled, water-cooled exhaust lines.

The triple-walled design permits
- low surface temperature,
- reduced thermal load,
- absolute gas-tightness.

### Lube oil system

Wet-sump forced-feed lubrication system

Components supplied with oil:
- Bearings
- Piston cooling
- Control and actuating elements of the sequential turbocharging system

### Cooling system

- Two separate cooling circuits:
  - Engine coolant
  - Raw water
- Coolant cooling by raw water-cooled plate-core heat exchanger
- Thermostat-controlled coolant system
- Coolant-cooled / preheated charge air
- Coolant-cooled fuel return

### Electronic system

Electronic control and monitoring system with integrated security and test system with interfaces to remote control system (RCS) and to monitoring system (MCS).

#### Electronic engine control unit (ECU)

Closed-loop control:
- Engine speed
- Fuel HP

TIM-ID: 0000002177 - 002

Open-loop control:
- Injection (fuel pressure, injection timing, injection duration, operating status)
- Sequential turbocharging (cutting-in and out) with secondary turbocharger
- Engine protection with multi-stage safety systems:
  - Power reduction
  - Power limitation
  - Emergency stop

Monitoring:
- Exhaust gas temperature, A-side
- Exhaust temperature, B-side
- Engine speed
- Oil pressure
- Differential oil pressure
- Coolant temperature
- Coolant level
- Exhaust turbocharger speed
- Leak fuel level
- Oil temperature
- Coolant pressure
- Fuel pressure after filter

### Monitoring in engine room

Engine control and monitoring unit (LOP)

Functions:
- Engine speed, oil pressure and coolant temperature are monitored and displayed
- Integrated safety system
- Integrated test system
- Redundant CAN bus interface to governor and higher-level control and monitoring system
- 24 V DC power supply

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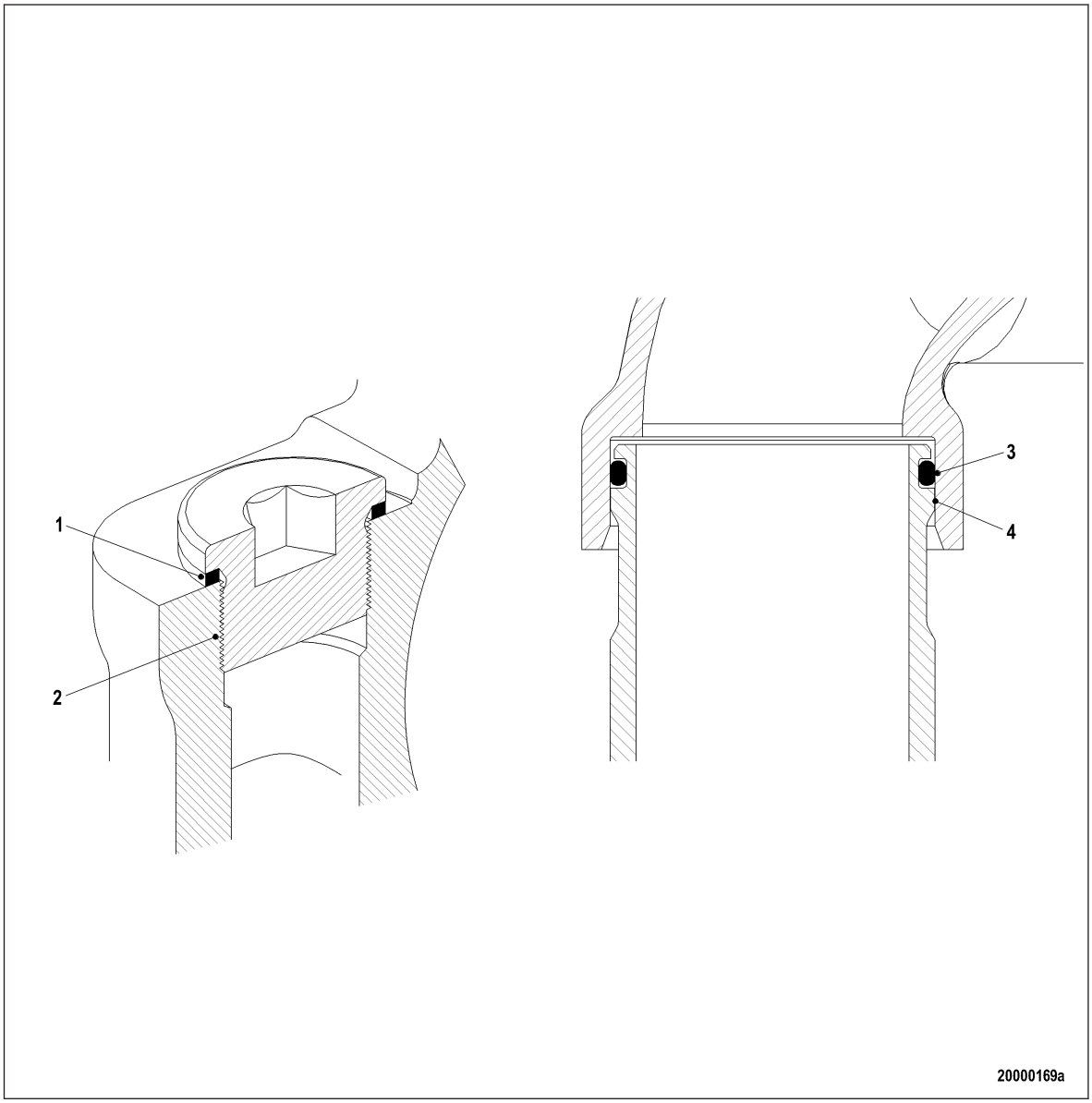
# SOLAS – Fire protection specifications

## Special connections




In case of leakage, the above-mentioned connection types are spray-protected even without a cover and have been confirmed compliant with SOLAS by GL and DNV.

### Plug-in pipe connection

The sleeve (4) covers the joint to prevent lateral spray.

Only leak-off along the line is possible, the pressure is decreased significantly if an O-ring (3) defect occurs.

The connection is confirmed as compliant with SOLAS by DNV and GL.

### Plugs and sensors

Screw-in plugs (2) are sealed toward the outside either with a copper sealing ring (1), according to DIN, or an O-ring (ISO).

In case of a loose single-ended union or a defective sealing ring (2), the liquid first has to pass the thread.

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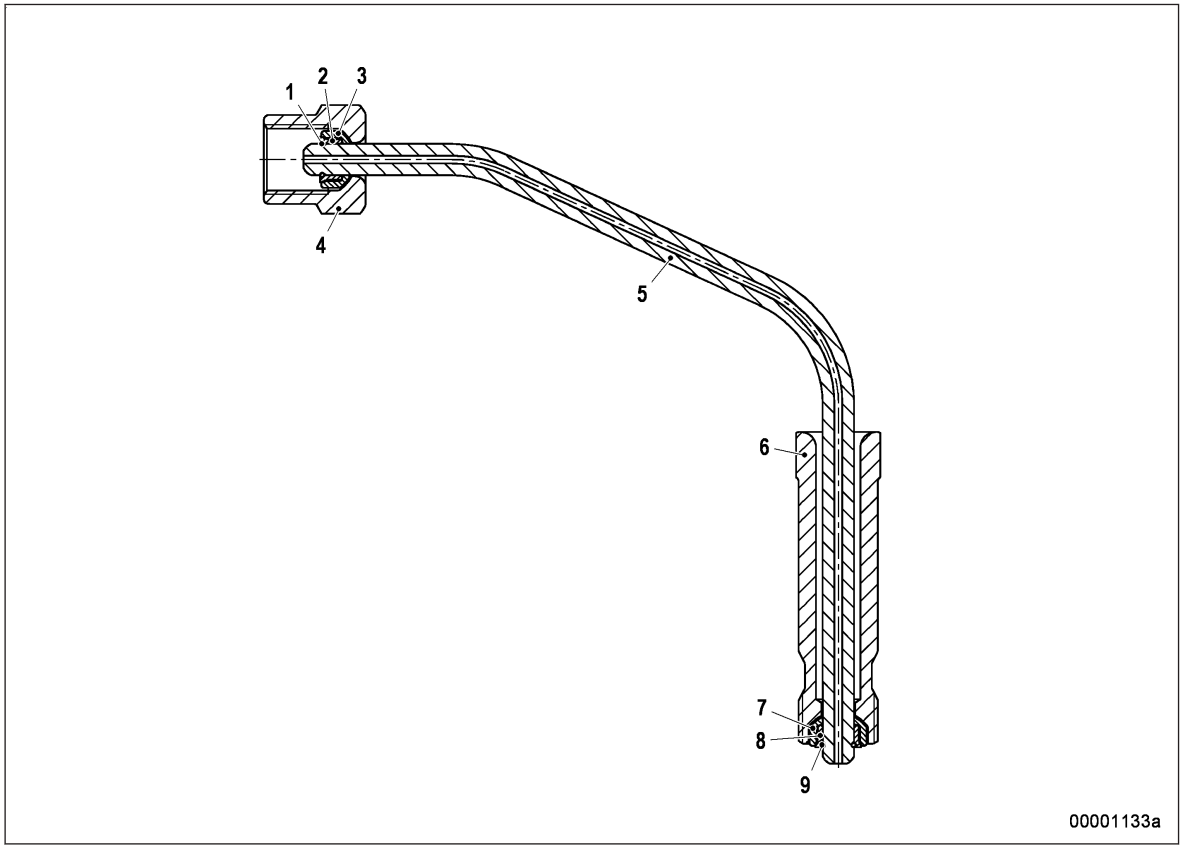
The pressure is so greatly reduced by this and the faulty sealing ring (2) that any leakage is not under pressure.

## HP line between fuel injector and HP accumulator




1 Support ring
2 V-ring
3 Thrust ring
4 Union nut
5 HP line
6 Thrust screw
7 Thrust ring
8 V-ring
9 Support ring

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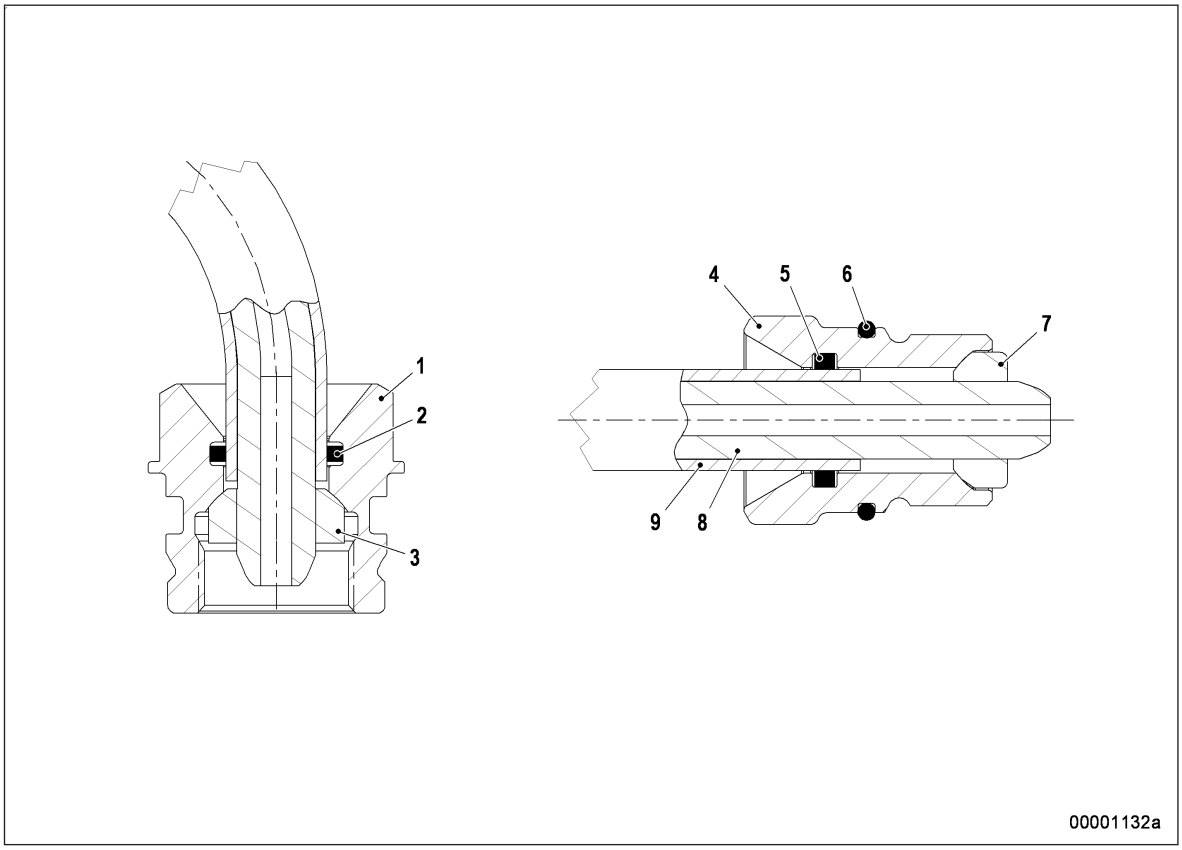
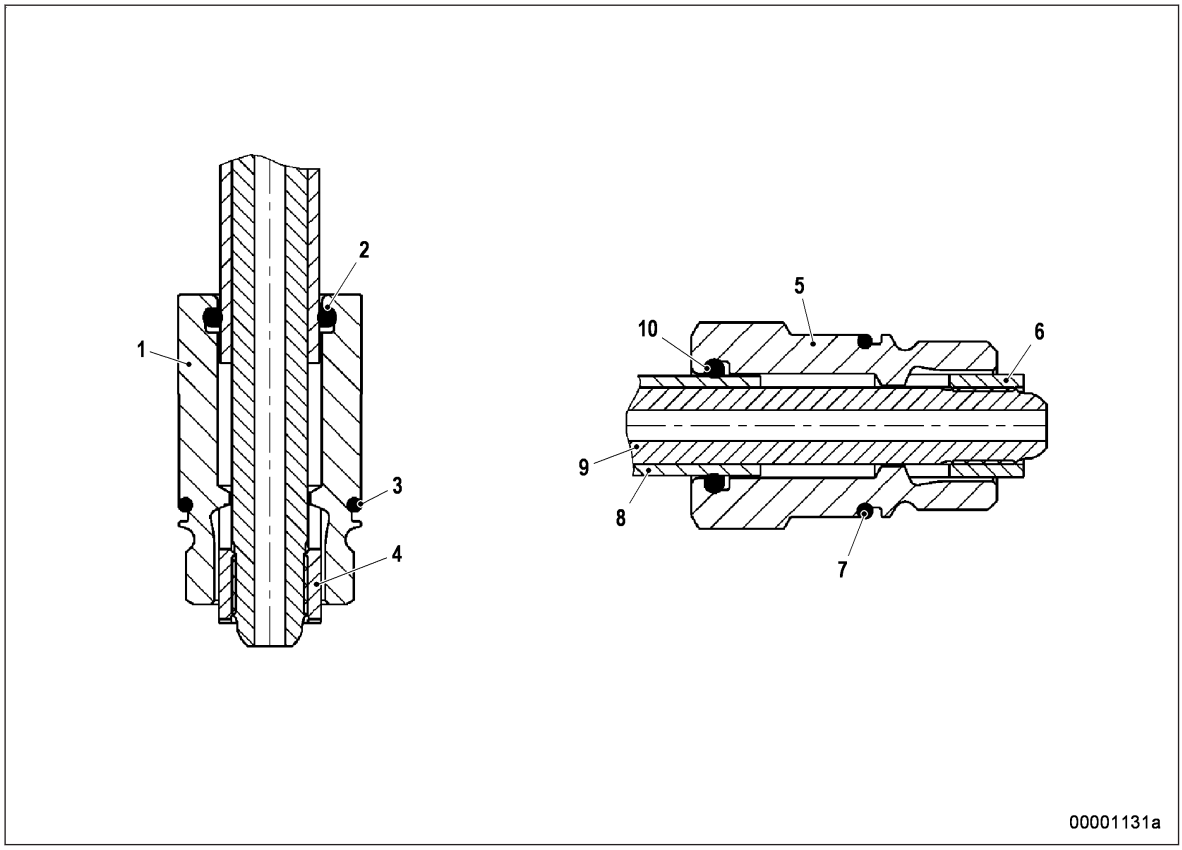
## HP line between distributor and HP accumulator




1 Union nut
2 O-ring
3 Thrust ring
4 Thrust screw
5 O-ring
6 O-ring
7 Thrust ring
8 Pressure pipe
9 Jacket pipe

TIM-ID: 0000002177 - 002

## HP line between distributor and HP accumulator



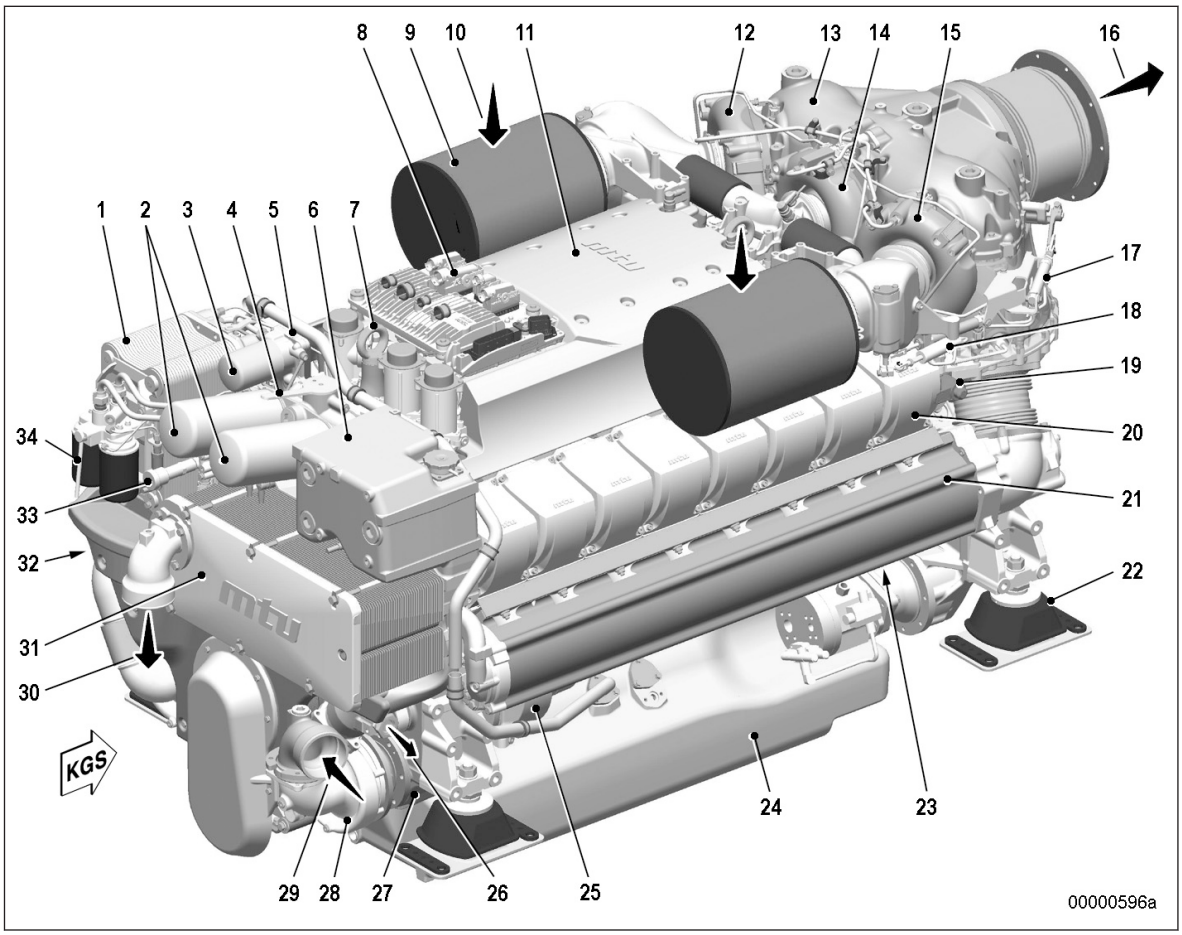

1 Jacket pipe
2 O-ring
3 O-ring
4 Thrust ring
5 Thrust screw
6 Thrust ring
7 O-ring
8 HP line
9 Pressure pipe
10 O-ring

Leak fuel caused by leakages from the sealing cones or the HP lines is returned to the HP pump, from where it is routed at atmospheric pressure into a level-monitored leak fuel tank.

TIM-ID: 0000002177 - 002

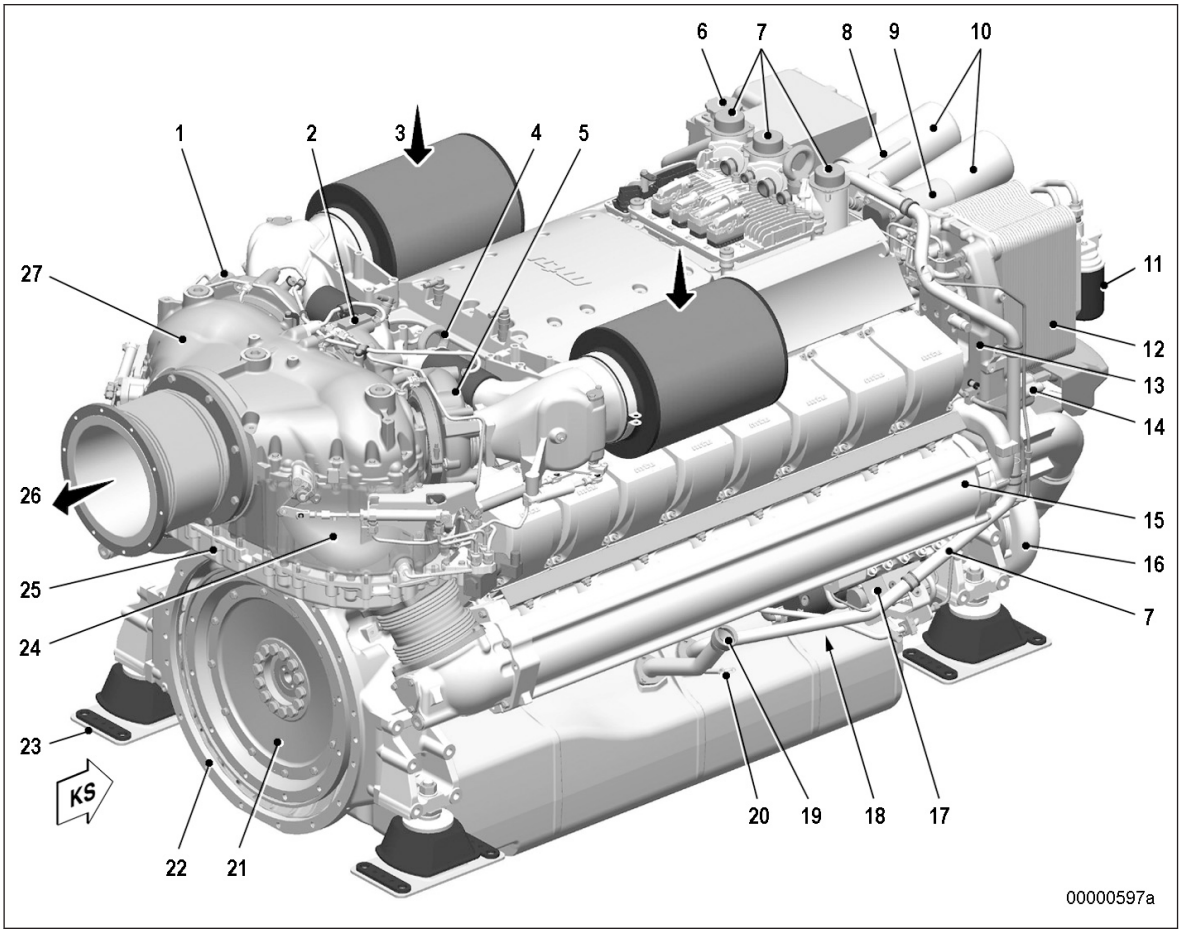
# 2.3 Engine layout

## Engine layout




1 Engine oil heat exchanger
2 Engine oil filter
3 Engine coolant filter
4 Change-over lever for engine oil filter
5 Fuel cooler
6 Coolant distribution housing with integral expansion tank
7 Engine hoisting lug (free end)
8 Electronic engine management system
9 Air filter
10 Air intake
11 Air collector housing (shroud)
12 Exhaust turbocharger, right (secondary turbocharger)
13 Carrier housing
14 Exhaust turbocharger (primary turbocharger)
15 Exhaust turbocharger, left (secondary turbocharger)
16 Exhaust outlet (horizontal)
17 Actuating cylinder for exhaust flap
18 Actuating cylinder for air flap
19 Control valve for flap control
20 Cylinder head cover
21 Exhaust manifold
22 Engine mounting
23 Electric starter
24 Oil pan
25 Battery-charging generator
26 Raw-water connection for gearbox cooling
27 Gearcase
28 Raw water pump
29 Raw-water connection from sea
30 Raw water connection to sea
31 Plate-core heat exchanger
32 Thermostat housing
33 Fuel priming pump
34 Fuel duplex filter (switchable)
KGS = free end

TIM-ID: 0000002087 - 001




1 Exhaust turbocharger, left (secondary turbocharger)
2 Exhaust turbocharger (primary turbocharger)
3 Air intake
4 Engine hoisting lug (driving end)
5 Exhaust turbocharger, right (secondary turbocharger)
6 Engine coolant filler neck
7 Crankcase breather
8 Change-over lever for engine oil filter
9 Engine coolant filter
10 Engine oil filter
11 Fuel filter
12 Engine oil heat exchanger
13 Coolant distribution housing with integral expansion tank
14 Thermostat housing
15 Exhaust manifold
16 Coolant pump
17 HP fuel pump
18 Fuel delivery pump
19 Oil filler neck
20 Oil dipstick
21 Drive flange
22 Flywheel housing
23 Engine mounting
24 Carrier housing core
25 Carrier housing lower part
26 Exhaust outlet
27 Carrier housing upper part
KS = driving end

## Engine model designation

Key to the model designation 12V/16V 2000 Mxy
- 12/16 = Number of cylinders
- V = Cylinder arrangement
- 2000 = Series
- Mx = application segment
- y = design index

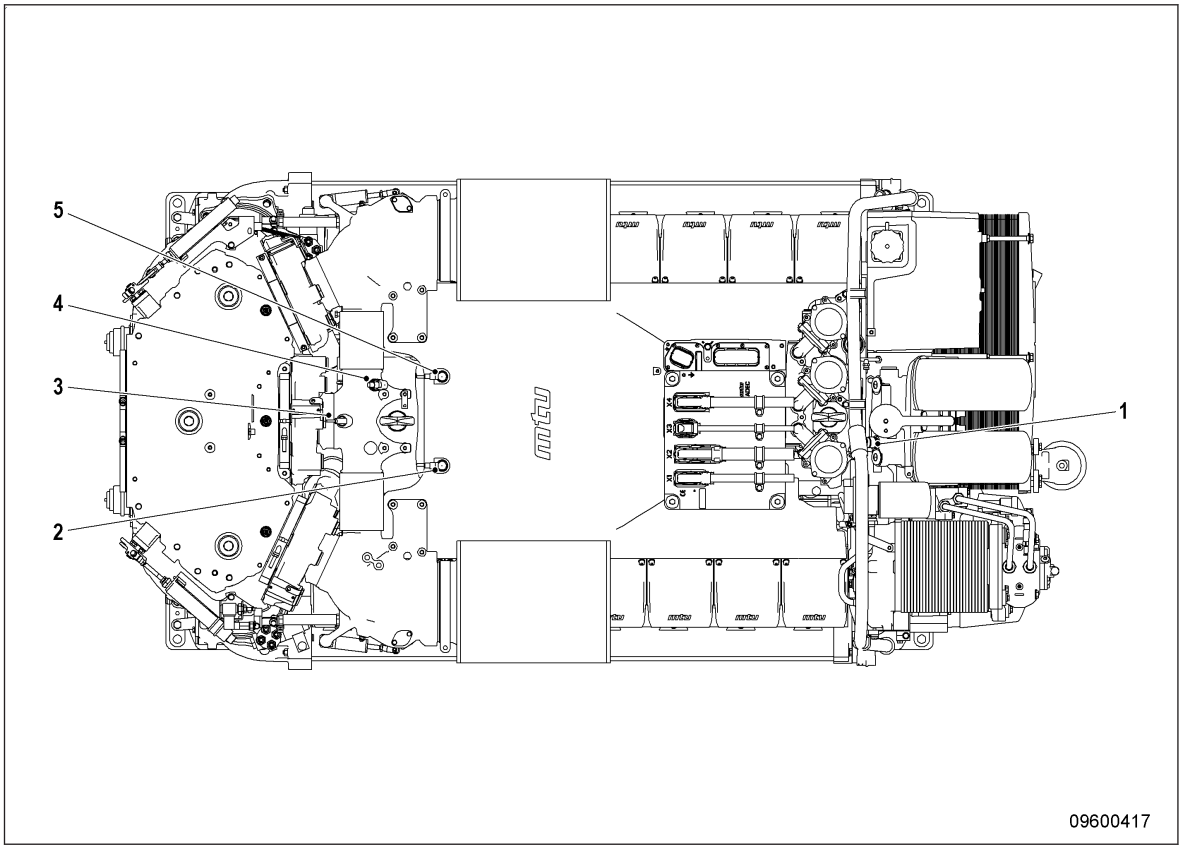
TIM-ID: 0000002087 - 001

# 2.4 Sensors, actuators and injectors – Overview

## Engine plan view

Deviations from illustrations are insignificant.

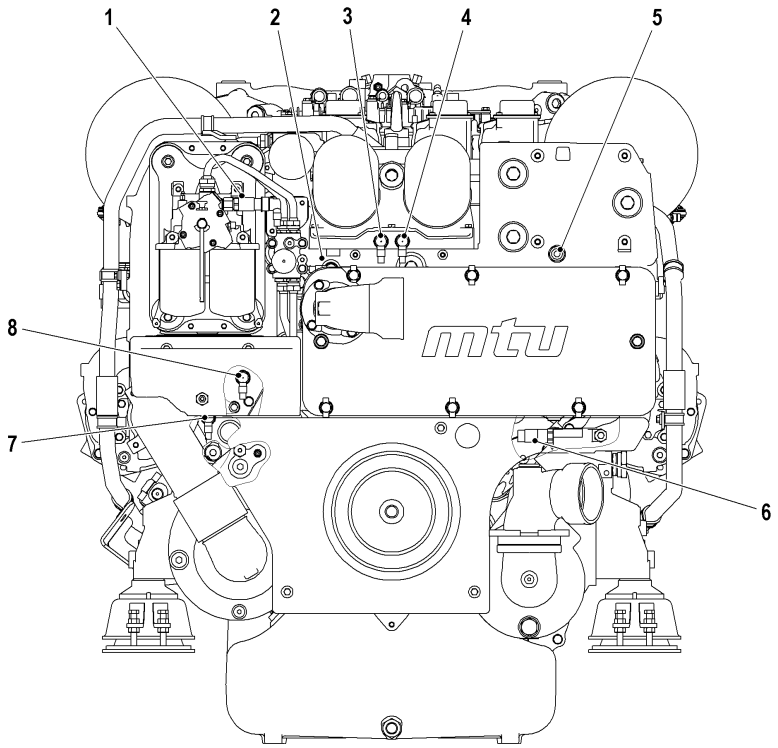
Also applies similarly to 12V.




| Item | Description | Monitoring of |
|---|---|---|
| 1 | B7 | Lube oil temperature |
| 2 | B10 | Charge-air pressure |
| 3 | B44 | Turbocharger speed |
| 4 | B3 | Intake air temperature |
| 5 | B9 | Charge-air temperature |

TIM-ID: 0000008412 - 003

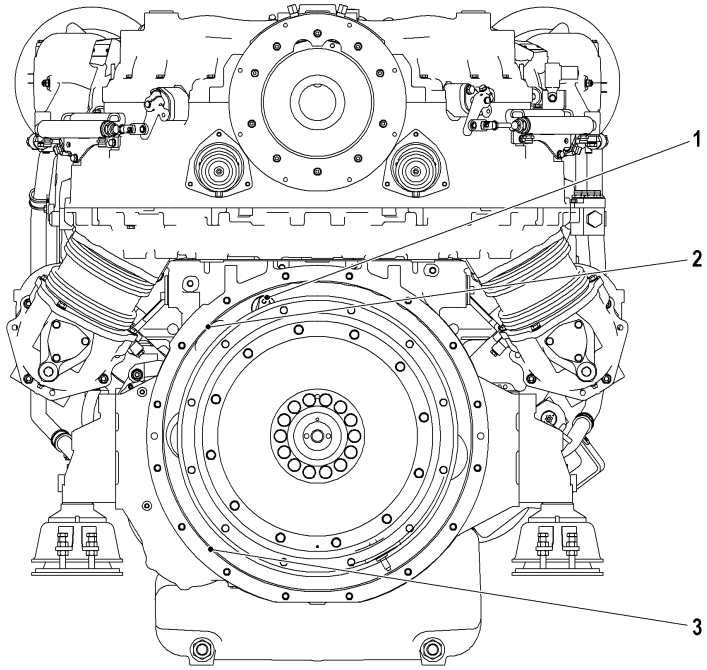
## Engine free end




| Item | Description | Monitoring of |
|---|---|---|
| 1 | B34 | Fuel pressure after filter |
| 2 | B5.3 (option) | Lube oil pressure before filter |
| 3 | B5.1 | Lube oil pressure after filter |
| 4 | B5.2 (option) | Lube oil pressure after filter |
| 5 | F33 | Engine coolant level, expansion tank |
| 6 | B21 (option) | Raw water pressure |
| 7 | B6.2 (option) | Coolant temperature |
| 8 | B6.1 | Coolant temperature |

TIM-ID: 0000008412 - 003

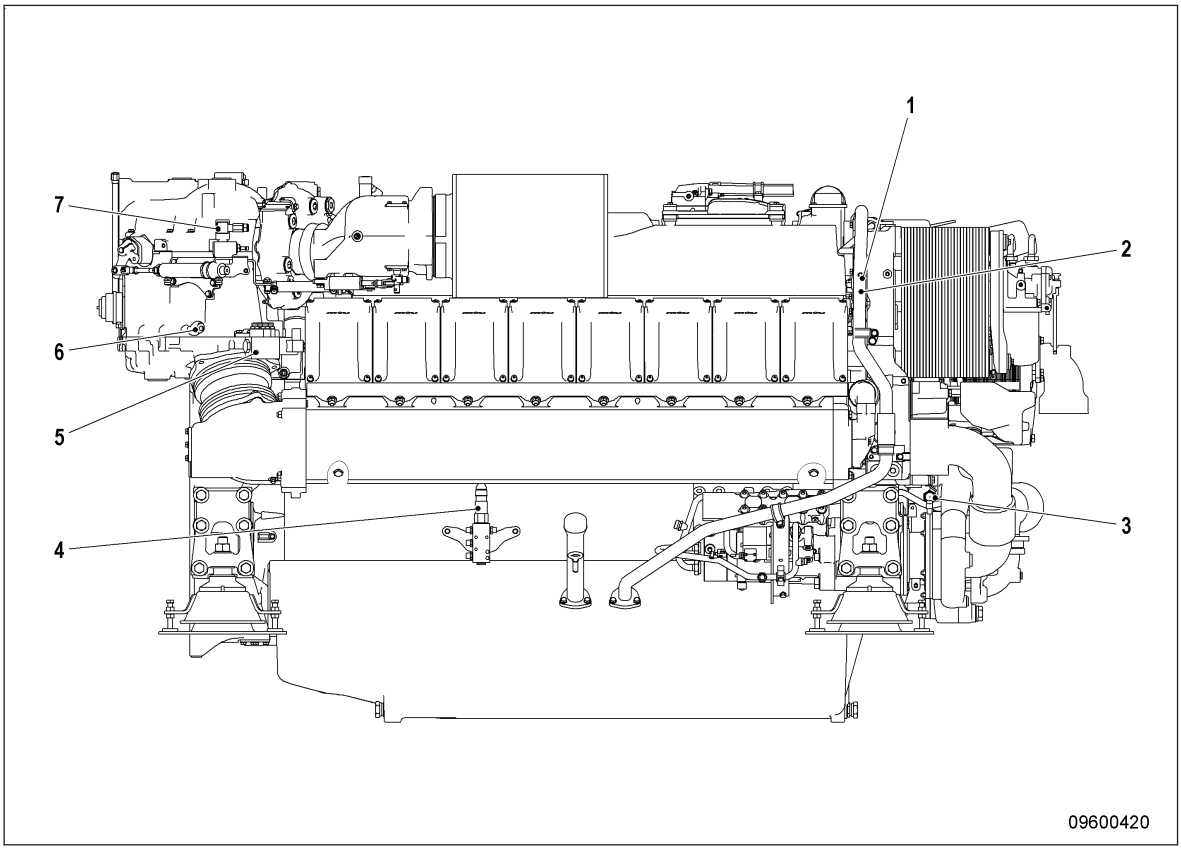
## Engine driving end




| Item | Description | Monitoring of |
|---|---|---|
| 1 | B1 (ECU) | Camshaft speed |
| 2 | B13.2 (optional EMU) | Crankshaft speed |
| 3 | B13 (ECU) | Crankshaft speed |

TIM-ID: 0000008412 - 003

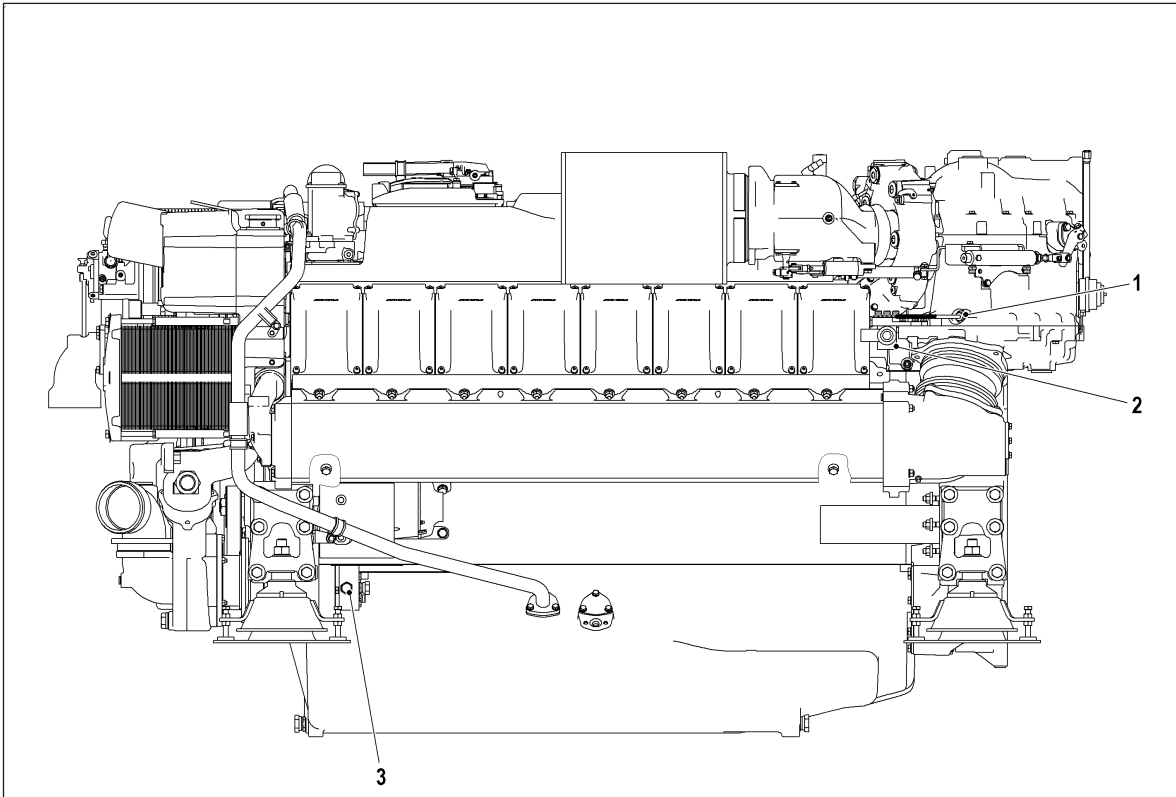
## Engine, right side




| Item | Description | Monitoring of |
|---|---|---|
| 1 | YB33 | Fuel temperature |
| 2 | B48 | Fuel pressure (in rail) |
| 3 | B16 (option) | Coolant pressure |
| 4 | F46 | Leak fuel level |
| 5 | Y27.2 | 4-2-directional control valve, B-side |
| 6 | B4.22 | Exhaust temperature, B-side |
| 7 | F41 | 2-2-directional control valve |

TIM-ID: 0000008412 - 003

## Engine, left side




| Item | Description | Monitoring of |
|---|---|---|
| 1 | B4.21 | Exhaust gas temperature, A-side |
| 2 | Y27.1 | 4-2-directional control valve, A-side |
| 3 | B54 (option) | Lube oil pressure, replenishment pump |

## System sensors

These sensors are fitted outside the engine.

| Description | Monitoring of |
|---|---|
| B19 | Starting-air pressure |
| B70 | Fuel prefilter water level |
| B41 | Exhaust back pressure |
| S37 | Start interlock, switching status |

TIM-ID: 0000008412 - 003

# 3 Technical Data

## 3.1 12V 2000 M72 engine data: Engine-mounted heat exchanger, EPA stage 2

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power settings).
N Not yet defined value
- Not applicable
X Applicable

### REFERENCE CONDITIONS

| Engine model | | | 12V 2000 M72 |
|---|---|---|---|
| Application group | | | 1B |
| Intake air temperature | | °C | 25 |
| Raw water inlet temperature | | °C | 25 |
| Barometric pressure | | mbar | 1000 |
| Site altitude above sea level | | m | 100 |

### POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Rated engine speed | A | rpm | 2250 |
| Fuel stop power ISO 3046 | A | kW | 1080 |

### GENERAL CONDITIONS (for maximum power)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Intake air depression (new filter) | A | mbar | 15 |
| Intake air depression, max. | L | mbar | 30 |

### MODEL RELATED DATA (basic design)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Cylinder arrangement: V angle | | degrees | 90 |
| Bore | | mm | 135 |
| Stroke | | mm | 156 |
| Cylinder displacement | | liters | 2.23 |
| Total displacement | | liters | 26.76 |

TIM-ID: 0000003110 - 001

| Number of cylinders | | | 12 |
|---|---|---|---|
| Inlet valves per cylinder | | | 2 |
| Exhaust valves per cylinder | | | 2 |

## RAW-WATER CIRCUIT (open circuit)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Raw water pump: Inlet pressure, min. | L | bar | -0.4 |
| Raw water pump: Inlet pressure, max. | L | bar | +0.5 |
| Pressure loss in off-engine raw-water system, max. | L | bar | 0.7 |

## LUBE OIL SYSTEM

| Number of cylinders | | | 12 |
|---|---|---|---|
| Lube oil operating temperature before engine, from | R | °C | 78 |
| Lube oil operating temperature before engine, to | R | °C | 88 |
| Lube oil operating pressure before engine, from | R | bar | 7.8 |
| Lube oil operating pressure before engine, to | R | bar | 8.8 |
| Lube oil operating pressure, low idle (meas. point: before engine) | R | bar | 3.0 |

## FUEL SYSTEM

| Number of cylinders | | | 12 |
|---|---|---|---|
| Fuel pressure at engine inlet connection, min. (when engine is starting) | L | bar | -0.3 |
| Fuel pressure at supply connection to engine (when engine is running), min. | L | bar | -0.3 |
| Fuel pressure at engine inlet connection, max. (when engine is starting) | L | bar | +0.25 |
| Fuel supply flow, max. | R | liter/min | 4.6 |

## GENERAL OPERATING DATA

| Number of cylinders | | | 12 |
|---|---|---|---|
| Firing speed, from | R | rpm | 100 |
| Firing speed, to | R | rpm | 200 |

## STARTING (electric)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Rated starter voltage (standard design) | R | V= | 24 |

TIM-ID: 0000003110 - 001

## INCLINATIONS, STANDARD OIL SYSTEM (Reference: waterline)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations) | L | degrees | 15 |
| Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations) | L | degrees | 22.5 |
| Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations) | L | degrees | 10 |
| Transverse inclination, continuous max. (Option: max. operating inclinations) | L | degrees | 22.5 |
| Transverse inclination, temporary max. (Option: max. operating inclinations) | L | degrees | 32.5 |

## CAPACITIES

| Number of cylinders | | | 12 |
|---|---|---|---|
| Engine coolant, engine-side (with cooler) | R | liters | 125 |
| Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations) | R | liters | 123 |
| Oil change quantity, max. (standard oil system) (Option: max. operating inclinations) | R | liters | 113 |
| Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations) | L | liters | 87 |
| Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations) | L | liters | 105 |

## WEIGHTS / MAIN DIMENSIONS

| Number of cylinders | | | 12 |
|---|---|---|---|
| Engine dry weight (with attached standard accessories, without coupling) | R | kg | 2780 |

## ACOUSTICS

| Number of cylinders | | | 12 |
|---|---|---|---|
| Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 105 |
| Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 102 |

TIM-ID: 0000003110 - 001

# 3.2 12 V 2000 M72 engine data: remote heat exchanger, EPA stage 2

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power setting)
N Not yet defined value
- Not applicable
X Applicable

## REFERENCE CONDITIONS

| Engine model | | | 12V2000 M72 |
|---|---|---|---|
| Application group | | | 1B |
| Intake air temperature | | °C | 25 |
| Raw water inlet temperature | | °C | 25 |
| Barometric pressure | | mbar | 1000 |
| Site altitude above sea level | | m | 100 |

## POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Rated engine speed | A | rpm | 2250 |
| Fuel stop power ISO 3046 | A | kW | 1080 |

## GENERAL CONDITIONS (for maximum power)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Intake depression (new filter) | A | mbar | 15 |
| Intake depression, max. | L | mbar | 30 |

## MODEL RELATED DATA (basic design)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Cylinder arrangement: V angle | | Degrees | 90 |
| Bore | | mm | 135 |
| Stroke | | mm | 156 |
| Cylinder displacement | | Liters | 2.23 |
| Total displacement | | Liters | 26.76 |
| Number of inlet valves per cylinder | | | 2 |
| Number of exhaust valves per cylinder | | | 2 |

TIM-ID: 0000010923 - 002

## LUBE OIL SYSTEM

| Number of cylinders | | | 12 |
|---|---|---|---|
| Lube oil operating temperature before engine, from | R | °C | 79 |
| Lube oil operating temperature before engine, to | R | °C | 89 |
| Lube oil operating pressure before engine, from | R | bar | 7.8 |
| Lube oil operating pressure before engine, to | R | bar | 8.8 |
| Lube oil operating pressure (low idle) (meas. point: before engine) | R | bar | 3.0 |

## FUEL SYSTEM

| Number of cylinders | | | 12 |
|---|---|---|---|
| Fuel pressure at engine inlet connection, min. (when engine is starting) | L | bar | -0.3 |
| Fuel pressure at engine inlet connection, min. (when engine is running), | L | bar | -0.3 |
| Fuel pressure at engine inlet connection (when engine is starting), max. | L | bar | +0.25 |
| Fuel supply flow, max. | R | Liters/min | 4.6 |

## GENERAL OPERATING DATA

| Number of cylinders | | | 12 |
|---|---|---|---|
| Firing speed, from | R | rpm | 100 |
| Firing speed, to | R | rpm | 200 |

## STARTER (electric)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Rated starter voltage (standard design) | R | V= | 24 |

## INCLINATIONS, STANDARD OIL SYSTEM (reference: waterline)

| Number of cylinders | | | 12 |
|---|---|---|---|
| Longitudinal inclination, continuous max. driving end down (option: max. operating inclinations) | L | Degrees | 15 |
| Longitudinal inclination, temporary max. driving end down (option: max. operating inclinations) | L | Degrees | 22.5 |
| Longitudinal inclination, temporary max., driving end up (option: max. operating inclinations) | L | Degrees | 10 |
| Transverse inclination, continuous max. (option: max. operating inclinations) | L | Degrees | 22.5 |
| Transverse inclination, temporary max. (option: max. operating inclinations) | L | Degrees | 32.5 |

TIM-ID: 0000010923 - 002

## CAPACITIES

| Number of cylinders | | | 12 |
|---|---|---|---|
| Engine oil capacity, initial filling (standard oil system) (option: max. operating inclinations) | R | Liters | 123 |
| Oil change quantity, max. (standard oil system) (option: max. operating inclinations) | R | Liters | 113 |
| Oil pan capacity at dipstick mark “min.” (standard oil system) (option: max. operating inclinations) | L | Liters | 87 |
| Oil pan capacity at dipstick mark “max.” (standard oil system) (option: max. operating inclinations) | L | Liters | 105 |

## WEIGHTS / MAIN DIMENSIONS

| Number of cylinders | | | 12 |
|---|---|---|---|
| Engine dry weight (with attached standard accessories, without coupling) | R | kg | 2770 |

## ACOUSTICS

| Number of cylinders | | | 12 |
|---|---|---|---|
| Exhaust noise, unsilenced,BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 105 |
| Engine surface noise with attenuated intake noise (filter) - BL (free-field sound pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 102 |

TIM-ID: 0000010923 - 002

# 3.3 16V 2000 M72 engine data: Engine-mounted heat exchanger, EPA stage 2

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power settings).
N Not yet defined value
- Not applicable
X Applicable

## REFERENCE CONDITIONS

| Engine model | | | 16V 2000 M72 |
|---|---|---|---|
| Application group | | | 1B |
| Intake air temperature | | °C | 25 |
| Raw water inlet temperature | | °C | 25 |
| Barometric pressure | | mbar | 1000 |
| Site altitude above sea level | | m | 100 |

## POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Rated engine speed | A | rpm | 2250 |
| Fuel stop power ISO 3046 | A | kW | 1440 |

## GENERAL CONDITIONS (for maximum power)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Intake air depression (new filter) | A | mbar | 15 |
| Intake air depression, max. | L | mbar | 30 |

## MODEL RELATED DATA (basic design)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Cylinder arrangement: V angle | | degrees | 90 |
| Bore | | mm | 135 |
| Stroke | | mm | 156 |
| Cylinder displacement | | liters | 2.23 |
| Total displacement | | liters | 35.68 |
| Inlet valves per cylinder | | | 2 |
| Exhaust valves per cylinder | | | 2 |

TIM-ID: 0000003108 - 001

## RAW-WATER CIRCUIT (open circuit)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Raw water pump: Inlet pressure, min. | L | bar | -0.4 |
| Raw water pump: Inlet pressure, max. | L | bar | +0.5 |
| Pressure loss in off-engine raw-water system, max. | L | bar | 0.7 |

## LUBE OIL SYSTEM

| Number of cylinders | | | 16 |
|---|---|---|---|
| Lube oil operating temperature before engine, from | R | °C | 77 |
| Lube oil operating temperature before engine, to | R | °C | 87 |
| Lube oil operating pressure before engine, from | R | bar | 6.0 |
| Lube oil operating pressure before engine, to | R | bar | 7.0 |
| Lube oil operating pressure, low idle (meas. point: before engine) | R | bar | 2.5 |

## FUEL SYSTEM

| Number of cylinders | | | 16 |
|---|---|---|---|
| Fuel pressure at engine inlet connection, min. (when engine is starting) | L | bar | -0.3 |
| Fuel pressure at supply connection to engine (when engine is running), min. | L | bar | -0.3 |
| Fuel pressure at engine inlet connection, max. (when engine is starting) | L | bar | +0.25 |
| Fuel supply flow, max. | R | liter/min | 6.2 |

## GENERAL OPERATING DATA

| Number of cylinders | | | 16 |
|---|---|---|---|
| Firing speed, from | R | rpm | 100 |
| Firing speed, to | R | rpm | 120 |

## STARTING (electric)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Rated starter voltage (standard design) | R | V= | 24 |

## INCLINATIONS, STANDARD OIL SYSTEM (Reference: waterline)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations) | L | degrees | 15 |
| Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations) | L | degrees | 22.5 |
| Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations) | L | degrees | 10 |
| Transverse inclination, continuous max. (Option: max. operating inclinations) | L | degrees | 22.5 |
| Transverse inclination, temporary max. (Option: max. operating inclinations) | L | degrees | 32.5 |

TIM-ID: 0000003108 - 001

## CAPACITIES

| Number of cylinders | | | 16 |
|---|---|---|---|
| Engine coolant, engine-side (with cooler) | R | liters | 135 |
| Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations) | R | liters | 168 |
| Oil change quantity, max. (standard oil system) (Option: max. operating inclinations) | R | liters | 155 |
| Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations) | L | liters | 115 |
| Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations) | L | liters | 138 |

## WEIGHTS / MAIN DIMENSIONS

| Number of cylinders | | | 16 |
|---|---|---|---|
| Engine dry weight (with attached standard accessories, without coupling) | R | kg | 3337 |

## ACOUSTICS

| Number of cylinders | | | 16 |
|---|---|---|---|
| Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 108 |
| Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 105 |

TIM-ID: 0000003108 - 001

# 3.4 16V 2000 M72 engine data: Separate heat exchanger, EPA stage 2

Explanation:

DL Ref. value: Continuous power
BL Ref. value: Fuel stop power
A Design value
G Guaranteed value
R Guideline value
L Limit value, up to which the engine can be operated, without change (e.g. of power settings).
N Not yet defined value
- Not applicable
X Applicable

## REFERENCE CONDITIONS

| Engine model | | | 16V 2000 M72 |
|---|---|---|---|
| Application group | | | 1B |
| Intake air temperature | | °C | 25 |
| Raw water inlet temperature | | °C | 25 |
| Barometric pressure | | mbar | 1000 |
| Site altitude above sea level | | m | 100 |

## POWER-RELATED DATA (power ratings are net brake power as per ISO 3046)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Rated engine speed | A | rpm | 2250 |
| Fuel stop power ISO 3046 | A | kW | 1440 |

## GENERAL CONDITIONS (for maximum power)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Intake air depression (new filter) | A | mbar | 15 |
| Intake air depression, max. | L | mbar | 30 |

## MODEL RELATED DATA (basic design)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Cylinder arrangement: V angle | | degrees | 90 |
| Bore | | mm | 135 |
| Stroke | | mm | 156 |
| Cylinder displacement | | liters | 2.23 |
| Total displacement | | liters | 35.68 |
| Inlet valves per cylinder | | | 2 |
| Exhaust valves per cylinder | | | 2 |

TIM-ID: 0000010937 - 002

## LUBE OIL SYSTEM

| Number of cylinders | | | 16 |
|---|---|---|---|
| Lube oil operating temperature before engine, from | R | °C | 78 |
| Lube oil operating temperature before engine, to | R | °C | 88 |
| Lube oil operating pressure before engine, from | R | bar | 6.0 |
| Lube oil operating pressure before engine, to | R | bar | 7.0 |
| Lube oil operating pressure, low idle (meas. point: before engine) | R | bar | 2.5 |

## FUEL SYSTEM

| Number of cylinders | | | 16 |
|---|---|---|---|
| Fuel pressure at engine inlet connection, min. (when engine is starting) | L | bar | -0.3 |
| Fuel pressure at supply connection to engine (when engine is running), min. | L | bar | -0.3 |
| Fuel pressure at engine inlet connection, max. (when engine is starting) | L | bar | +0.25 |
| Fuel supply flow, max. | R | liter/min | 6.2 |

## GENERAL OPERATING DATA

| Number of cylinders | | | 16 |
|---|---|---|---|
| Firing speed, from | R | rpm | 100 |
| Firing speed, to | R | rpm | 120 |

## STARTING (electric)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Rated starter voltage (standard design) | R | V= | 24 |

## INCLINATIONS, STANDARD OIL SYSTEM (Reference: waterline)

| Number of cylinders | | | 16 |
|---|---|---|---|
| Longitudinal inclination, continuous max., driving end down (Option: max. operating inclinations) | L | degrees | 15 |
| Longitudinal inclination, temporary max., driving end down (Option: max. operating inclinations) | L | degrees | 22.5 |
| Longitudinal inclination, temporary max., driving end up (Option: max. operating inclinations) | L | degrees | 10 |
| Transverse inclination, continuous max. (Option: max. operating inclinations) | L | degrees | 22.5 |
| Transverse inclination, temporary max. (Option: max. operating inclinations) | L | degrees | 32.5 |

TIM-ID: 0000010937 - 002

## CAPACITIES

| Number of cylinders | | | 16 |
|---|---|---|---|
| Total engine oil capacity at initial filling (standard oil system) (Option: max. operating inclinations) | R | liters | 168 |
| Oil change quantity, max. (standard oil system) (Option: max. operating inclinations) | R | liters | 155 |
| Oil pan capacity at dipstick mark "min." (standard oil system) (Option: max. operating inclinations) | L | liters | 115 |
| Oil pan capacity at dipstick mark "max." (standard oil system) (Option: max. operating inclinations) | L | liters | 138 |

## WEIGHTS / MAIN DIMENSIONS

| Number of cylinders | | | 16 |
|---|---|---|---|
| Engine dry weight (with attached standard accessories, without coupling) | R | kg | 3337 |

## ACOUSTICS

| Number of cylinders | | | 16 |
|---|---|---|---|
| Exhaust noise, unsilenced, BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 108 |
| Engine surface noise with attenuated intake noise (filter), BL, (free-field sound-pressure level Lp, 1m distance, ISO 6798) | R | dB(A) | 105 |

TIM-ID: 0000010937 - 002

## 3.5 Firing order

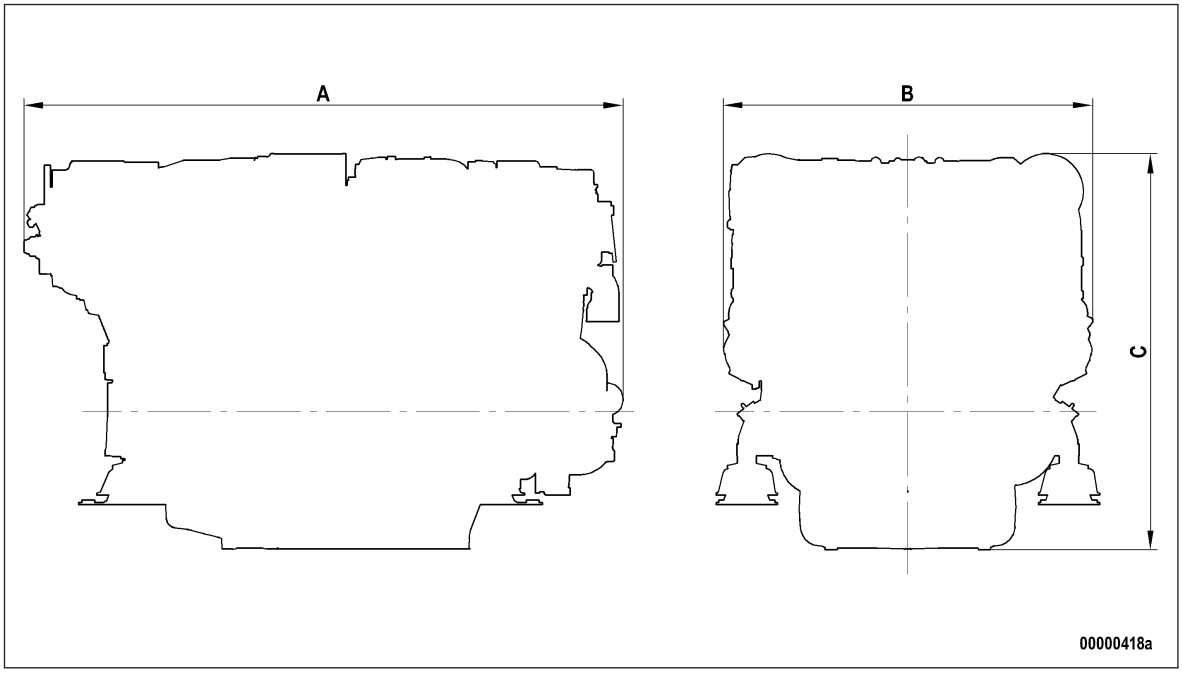
### Firing order

| | |
|---|---|
| 8V | A1-B4-A4-A2-B3-A3-B2-B1 |
| 10 V | A1-B4-A4-B3-A3-B2-A2-B5-A5-B1 |
| 12 V | A1-B5-A5-B3-A3-B6-A6-B2-A2-B4-A4-B1 |
| 16 V | A1-B5-A3-A5-B2-B8-A2-A8-B3-A7-B4-B6-A4-A6-B1-B7 |

TIM-ID: 0000002801 - 003

# 3.6 Engine – Main dimensions

## Main dimensions




| Engine model | Length (A) | Width (B) | Height (C) |
|---|---|---|---|
| 8V 2000 M72 | approx. 1683 mm | approx. 1147 mm | approx. 1200 mm |
| 8V 2000 M92 | approx. 1683 mm | approx. 1147 mm | approx. 1200 mm |
| 8V 2000 M93 | approx. 1683 mm | approx. 1147 mm | approx. 1200 mm |
| 8V 2000 M84 | approx. 1683 mm | approx. 1147 mm | approx. 1200 mm |
| 8V 2000 M94 | approx. 1683 mm | approx. 1147 mm | approx. 1200 mm |
| 10V 2000 M72 | approx. 1860 mm | approx. 1147 mm | approx. 1320 mm |
| 10V 2000 M92 | approx. 1860 mm | approx. 1147 mm | approx. 1320 mm |
| 10V 2000 M93 | approx. 1860 mm | approx. 1147 mm | approx. 1320 mm |
| 10V 2000 M84 | approx. 1860 mm | approx. 1147 mm | approx. 1320 mm |
| 10V 2000 M94 | approx. 1860 mm | approx. 1147 mm | approx. 1320 mm |
| 12V 2000 M92 | approx. 2069 mm | approx. 1295 mm | approx. 1350 mm |
| 12V 2000 M93 | approx. 2069 mm | approx. 1295 mm | approx. 1350 mm |
| 12V 2000 M84 | approx. 2094 mm | approx. 1295 mm | approx. 1350 mm |
| 12V 2000 M94 | approx. 2094 mm | approx. 1295 mm | approx. 1350 mm |
| 16V 2000 M92 | approx. 2486 mm | approx. 1295 mm | approx. 1390 mm |
| 16V 2000 M93 | approx. 2486 mm | approx. 1295 mm | approx. 1390 mm |
| 16V 2000 M84 | approx. 2511 mm | approx. 1295 mm | approx. 1390 mm |
| 16V 2000 M94 | approx. 2511 mm | approx. 1295 mm | approx. 1390 mm |

TIM-ID: 0000002153 - 002

# 4 Operation

## 4.1 Engine – Putting the engine into operation (out of service > 3 months)

### Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Putting the engine into operation (out-of-service period > 3 months)

| Item | Measure |
|---|---|
| Engine | Depreserve (→ MTU Fluids and Lubricants Specifications A001061/..). |
| Lube oil system | Check engine oil level (→ Page 102). |
| Fuel prefilter | Fill with fuel (→ Page 95).<br>Align adjustable pointer with position of pressure indicator (→ Page 91). |
| Fuel system | Vent (→ Page 88). |
| Raw water pump (if located above waterline) | Fill with water (approx. 3 – 4 liters).<br>Filling point (→ Page 109). |
| Coolant circuit | If engine is out of service for more than one year, change engine coolant (→ Page 116).<br>Check coolant level (→ Page 115).<br>Heat engine coolant with coolant preheating unit. |
| Engine control system | Switch on (→ Operating Instructions for BlueVision). |
| Engine | Start (→ Operating Instructions for BlueVision ). |

TIM-ID: 0000002214 - 002

## 4.2 Putting the engine into operation after scheduled out-of-service period

### Preconditions

☑ Engine is stopped and starting disabled.

### Startup

| Item | Task |
|---|---|
| Lube oil system | Check oil level (→ Page 102). |
| Coolant system | Check coolant level (→ Page 115). |
| Coolant system | Preheat coolant with preheating unit. |
| Fuel prefilter | Drain (→ Page 92). |
| Battery-charging generator drive | Check condition of drive belt (→ Page 123). |
| Engine control system | Switch on (→ Operating instructions BlueVision ). |
| Engine | Start (→ Operating instructions BlueVision ). |

TIM-ID: 0000002690 - 001

## 4.3 Tasks after extended out-of-service periods (>3 weeks)

### Tasks after extended out-of-service periods (>3 weeks)

Note: Operate fuel treatment system for at least 5 minutes.

1. Start up fuel treatment system (→ Page 50).
2. Shut down fuel treatment system (→ Page 58).

TIM-ID: 0000007730 - 005

## 4.4 Checks prior to start-up

### Checks prior to start-up

1. Check tank and the entire pipework for cleanness. If microorganisms are detected:
   a) Clean affected components.
   b) Disinfect affected components with biocides (→ MTU Fluids and Lubricants Specifications A001061/..).
2. Close drain valves on housing.
3. Open all supply and discharge valves.
4. Switch on fuel treatment system (→ Page 53).
5. Check direction of rotation of pump.
6. Vent bypass and fuel lines of the system.
   a) Open ball valve for pressure tank.
   b) Open ball valve for overflow tank.
   c) Close ball valve at the inlet to the fuel treatment system.

Result: Bypass line is vented via the overflow tank.

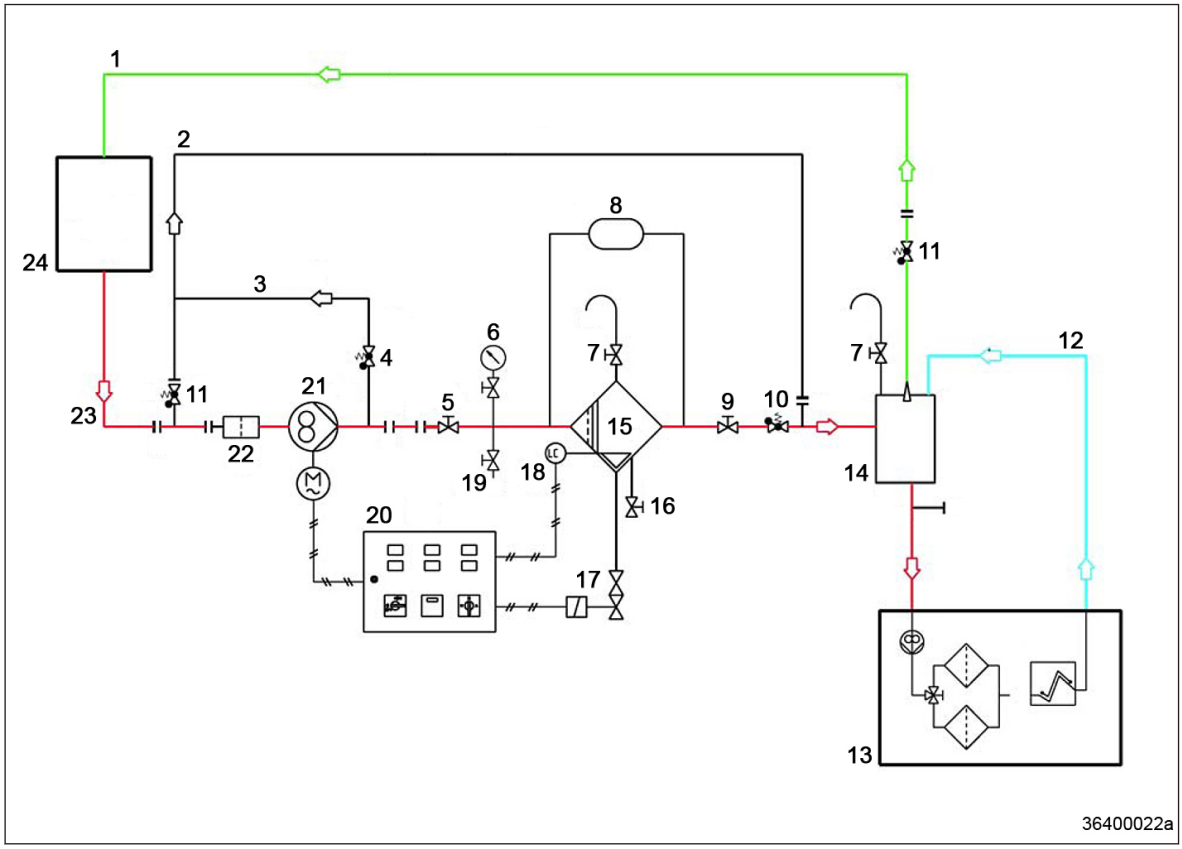
   d) Open ball valve at the inlet to the fuel treatment system.
7. Check the fuel treatment system for leaks.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007736 - 005

# 4.5 Fuel treatment system – Putting into operation

## Fuel treatment system – Overview




1. Switch on fuel treatment system (→ Page 53).
2. Check the differential pressure at differential pressure gauge (8). Differential pressure in a new system: 0.1 bar to 0.3 bar.

Result: If no differential pressure is measured, the coalescer filter element is probably being bypassed.
1. Remove coalescer filter element (→ Page 129).
2. Check sealing faces on coalescer filter element and in the pressure tank.

## Initial operation: HAT

1. Replace fuel filter on engine (→ Page 89).

Note: Determine the suction pressure upstream of the engine-mounted fuel delivery pump.
2. Install a pressure gauge in the fuel supply line from the shipyard-side fuel system to the engine.
3. Switch on fuel treatment system and operate it for some minutes (→ Page 53).

Result: Fuel is sucked from the tank, dirt particles and water are filtered and separated, then the fuel is delivered via the overflow tank back to the tank. Water which has settled in the tank is separated.
4. Start engine (→ Page 54).
5. Run engine at idling speed.
6. Check suction pressure (see technical data of the engine) at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:
7. Increase engine speed to 1000 rpm and monitor suction pressure.
8. Check suction pressure at the engine-mounted fuel delivery pump.

Result: If the values are within the limits specified by the manufacturer, the system is ready to start filter replacement simulation with the engine running as part of the Harbor Acceptance Tests.

TIM-ID: 0000007738 - 005

## Simulation of filter replacement with the engine running: HAT

1. Switch on fuel treatment system (→ Page 53).
2. Start engine (→ Page 54).
3. Run engine at idling speed.
4. Close ball cock (5) at the inlet to the fuel treatment system.

Result: The pressure upstream of the fuel treatment system increases until the overflow valve at the pump unit opens and fuel flows through bypass (3) and bypass (2).

5. Open ball cock (19).

Result: Fuel emerges. If no fuel emerges:
- Open ball cock (5) at the inlet to the fuel treatment system.
- No function of bypasses (2) and (3); carry out functional test of bypasses (2) and (3).

6. Check suction pressure (see technical data of the engine) at the fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:

7. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If all engine operating values are within the specified limits, open ball cock (5) at the inlet to the fuel treatment4 system.

## Simulation of power failure (emergency): HAT

1. Switch on fuel treatment system (→ Page 53).
2. Start engine (→ Page 54).
3. Run engine at idling speed.
4. Switch off pump (21) on switch cabinet.

Result: The engine-mounted fuel delivery pump sucks fuel via bypass (2) directly from the tank.

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory.

6. Increase engine speed to 1000 rpm and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

## Simulation of power failure (emergency): SAT

1. Switch on fuel treatment system (→ Page 53).
2. Start engine (→ Page 54).
3. Run engine at idling speed.
4. Switch off pump (21) on switch cabinet.

Result: The engine-mounted fuel delivery pump sucks fuel via bypass (2) directly from the tank.

5. Check suction pressure at the engine-mounted fuel delivery pump.

Note: If the suction pressure is within the permissible limits and engine operation is satisfactory:

6. Operate engine at full load and monitor suction pressure.

Result: If the suction pressure is within the specified limits, simulation was successful.

TIM-ID: 0000007738 - 005

## 4.6 Operational checks

DANGER

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

WARNING

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### Operational checks

| Item | Measure |
|---|---|
| Engine under load | Visually inspect engine for leaks and general condition; |
| Engine at nominal speed | Check for abnormal running noises and vibration; |
| | Check exhaust color (→ Page 62). |
| Fuel prefilter | Check if suction-side pressure indicated at the fuel prefilter pressure gauge is within the limit (→ Page 91). |
| | Drain water and contaminants (→ Page 92). |
| Air filter | Check signal ring position of service indicator (→ Page 100). |
| HT coolant pump | Check relief bore for oil and coolant discharge and contamination (→ Page 119). |
| Raw water pump | Check relief bore for oil and water discharge and contamination (→ Page 122). |
| Intercooler | Check condensate drain (if applicable) (→ Page 97). |
| Engine oil | Check engine oil level (→ Page 102). |

TIM-ID: 0000002274 - 005

# 4.7 Fuel treatment system – Switching on

## Preconditions

☑ The on-board power supply is switched on.

CAUTION

Damage to engine/plant.
**Major material damage!**
- Before switching on, ensure that the engine/plant is ready for operation.
- Before switching on, ensure that all housings are closed.
- Before switching on, ensure that no work is in progress anywhere on the entire system.

## Switching on fuel treatment system

1. Carry out checks prior to start-up (→ Page 49).
2. Switch on master switch on switch cabinet.

Result: Signal lamp “Control voltage present” lights up.

3. Switch on switch for pump.

Result: Signal lamp “Pump running” lights up.

TIM-ID: 0000007731 - 005

## 4.8 Starting the engine

### Preconditions

☑ External start interlock is not activated.

☑ Emergency air shut-off flaps (if fitted) are open.

**DANGER**

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Before barring or starting the engine, make sure that nobody is in the danger zone.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### The engine can be started from the following points :

1. (→ Operating instructions for electronic system)
2. Commanding control stand (→ Operating instructions for electronic system);
3. Local operating panel LOP (→ Operating instructions for electronic system);
4. Local Operation Station LOS (→ Operating instructions for electronic system);
5. CCU (→ Operating instructions for electronic system).

TIM-ID: 0000002240 - 002

## 4.9 Stopping the engine

### Preconditions

☑ Engine is running in local mode.

CAUTION

Stopping the engine when it is running at full load causes extreme stress to the engine.
**Risk of overheating, damage to components!**

- Before shutting down, disengage gear and run the engine at idle speed for at least 10 mins. until engine temperatures have dropped and constant values are displayed.

### The engine can be stopped from the following points :

1. (→ Operating instructions for electronic system)
2. Commanding control stand (→ Operating instructions for electronic system);
3. Local operating panel LOP (→ Operating instructions for electronic system);
4. Local Operation Station LOS (→ Operating instructions for electronic system);
5. CCU (→ Operating instructions for electronic system).

TIM-ID: 0000002298 - 002

## 4.10 Emergency stop

CAUTION

An emergency stop causes extreme stress to the engine.
**Risk of overheating, damage to components!**
- Initiate emergency stop only in emergency situations.

### An emergency stop of the engine can be initiated from the following points :

1. (→ Operating instructions for electronic system)
2. Commanding control stand (→ Operating instructions for electronic system);
3. Local operating panel LOP (→ Operating instructions for electronic system);
4. Local Operation Station LOS (→ Operating instructions for electronic system);
5. CCU (→ Operating instructions for electronic system).

TIM-ID: 0000002312 - 002

# 4.11 After stopping the engine

## Preconditions

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

## After stopping the engine

| Item | Action |
|---|---|
| Coolant circuit | Drain coolant (→ Page 117) if:<br>• freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive;<br>• the engine room is not heated;<br>• the coolant is not kept at a suitable temperature;<br>• the antifreeze concentration is insufficient for the engine-room temperature;<br>• antifreeze concentration is 50 % and engine-room temperature is below -40 °C. |
| Raw water | Drain<br>• If freezing temperatures are to be expected and the engine is to remain out of service for an extended period. |
| Engine control system | Switch off. |
| Air intake and exhaust system | Out-of-service-period > 1 week<br>• Seal engine's air and exhaust sides. |
| Engine | Out-of-service-period > 1 month<br>• Preserve engine (→ MTU Fluids and Lubricants Specifications A001061/.. ) |

TIM-ID: 0000002324 - 007

## 4.12 Fuel treatment system – Shutdown

### Shutting down fuel treatment system

1. Press the illuminated pushbutton "Water drain" on the switch cabinet until water discharge from the outlet stops.
2. Switch off fuel treatment system.
3. Close ball valve at the inlet to the fuel treatment system.
4. Close ball valve at the outlet of the fuel treatment system.
5. Open drain valve until pressure has escaped from fuel treatment system.

TIM-ID: 0000007732 - 005

## 4.13 Plant – Cleaning

### Preconditions

☑ Engine is stopped and starting disabled.

☑ Operating voltage is not applied.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Steam jet cleaner | - | 1 |
| Cleaner (Hakupur 312) | 30390 | 1 |

**WARNING**

Compressed air
**Risk of injury!**
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

**WARNING**

Water jet.
**Risk of injury and scalding!**
- Do not direct water jet at persons.
- Wear protective clothing, gloves, and goggles / safety mask.

**CAUTION**

Excessive reaction time of cleaning agents on components.
**Damage to component!**
- Observe manufacturer's instructions.
- Wear protective clothing, gloves, and goggles / safety mask.

Note: There is a risk of damaging sensors with compressed air.

### Plant – Cleaning

1. Carry out plant cleaning only in areas where an appropriate oil separator is provided (environmental protection).
2. Prior to putting the cleaning unit into operation, read the Operating Instructions of the water/steam jet unit carefully and observe the safety precautions.
3. For external cleaning with high-pressure jet, use a flat-mouth nozzle only.
4. Carry out external cleaning as follows:
   a) Remove coarse dirt.
   b) Spray on cleaner sparingly and leave it for 1 to 5 minutes.
   c) Use the high-pressure jet to remove the loosened dirt.
   d) During external cleaning of the plant with water/steam-jet units, the pressure of the high-pressure jet (cleaning jet) must not exceed 50 bar. A minimum distance between spray nozzle and plant of 1 m must be observed. The temperature of the cleaning medium must not exceed 80 °C.

TIM-ID: 0000010171 - 021

# 5 Maintenance

## 5.1 Maintenance task reference table [QL1]

The maintenance tasks and intervals for this product are defined in the Maintenance Schedule. The Maintenance Schedule is a stand-alone publication.

The task numbers in this table provide reference to the maintenance tasks specified in the Maintenance Schedule.

| Task | Maintenance tasks | |
|---|---|---|
| W0500 | Check engine oil level | (→ Page 52) |
| W0501 | Visually inspect engine for leaks and general condition | (→ Page 52) |
| W0502 | Check intercooler drain (if fitted) | (→ Page 52) |
| W0503 | Check air filter service indicator | (→ Page 52) |
| W0505 | Check relief bores of coolant pump(s) | (→ Page 52) |
| W0506 | Check engine for abnormal running noises, exhaust color and vibrations | (→ Page 52) |
| W0507 | Drain water and dirt from fuel prefilter (if fitted) | (→ Page 52) |
| W0508 | Check reading on differential pressure gauge of fuel prefilter (if fitted) | (→ Page 52) |
| W1001 | Replace fuel filter or fuel filter element | (→ Page 89) |
| W1002 | Check valve clearance | (→ Page 81) |
| W1003 | Check drive belt condition and tension, replace as necessary | (→ Page 123) |
| W1005 | Replace air filter | (→ Operating Instructions) |
| W1006 | Replace fuel injectors | (→ Page 85) |
| W1008 | Replace engine oil filter at each oil change or when the time limit (years) is reached, at the latest | (→ Page 104) |
| W1009 | Check layer thickness of oil residue, clean and replace filter sleeve (if fitted) | (→ Page 106) |
| W1011 | Perform endoscopic inspection of combustion chambers | (→ Page 74) |
| W1036 | Replace coolant filter | (→ Page 121) |
| W1139 | Replace paper or knitted fabric insert (if fitted) of oil mist separator. | (→ Page 79) |
| W1140 | Clean wire meshes of crankcase breather | (→ Page 78) |
| W1244 | Check operation of rod electrode (if fitted) | (→ Page 127) |
| W1245 | Check alarm function of differential-pressure gauge(if fitted) | (→ Page 126) |
| W1246 | Check pump capacity (if fitted) | (→ Page 128) |

*Table 1: Maintenance task reference table [QL1]*

TIM-ID: 0000033801 - 001

# 6 Troubleshooting

## 6.1 Fuel treatment system – Troubleshooting

### Illuminated pushbutton “Water alarm” is lit.

| Cause | Corrective action |
|---|---|
| When the maximum water level is reached, the water level electrode opens the water drain valve and water is discharged. If the opening period of the valve exceeds a preset limit (4 minutes), the pump will switch off and an alarm is initiated. | 1. Press illuminated pushbutton “Water alarm” to acknowledge.<br>2. In addition to the automatic water drain function, water can also be drained manually. To do so, press the illuminated pushbutton “Water drain” to open the drain valve. |

### Signal lamp “Pump fault” is lit.

| Cause | Corrective action |
|---|---|
| The drive motor is equipped with an overload protection. If the maximum permissible current consumption is exceeded, e.g. in case of a blockage or dry-running, the motor protection relay triggers and the pump is switched off. | ▶ Reset motor protection relay. |

### Signal lamp “Warning filter” is lit.

| Cause | Corrective action |
|---|---|
| The differential pressure exceeded 1.3 bar. | ▶ Replace coalescer filter element (→ Page 129). |

### Illuminated pushbutton “Replace filter element” is lit.

| Cause | Corrective action |
|---|---|
| The max. permissible differential pressure of 1.5 bar was exceeded. If the coalescer filter element is not replaced, pressure will increase further and the safety valve will open. Fuel will be led via the bypass directly into the overflow tank. | 1. Replace coalescer filter element (→ Page 129).<br>2. Press illuminated pushbutton “Replace filter element” to acknowledge. |

TIM-ID: 0000007734 - 005

# 6.2 Troubleshooting

## Engine does not turn when starter is actuated

| Component | Probable Cause | Task |
|---|---|---|
| Battery | Low or defective | Charge or replace (see manufacturer's documentation). |
| | Cable connections defective | Check if cable connections are properly secured (see manufacturer's documentation). |
| Starter | Engine wiring or starter defective | Check if cable connections are properly secured, contact Service. |
| Engine wiring | Defective | Check (→ Page 131). |
| ECU | Plug-in connections are loose | Check plug-in connections for secure seating. |
| Engine | Running gear blocked (engine cannot be barred manually) | Contact Service. |

## Engine turns but does not fire

| Component | Probable Cause | Task |
|---|---|---|
| Starter | Poor rotation by starter: Battery low or defective | Charge or replace battery (see manufacturer's documentation). |
| Engine wiring | Defective | Check (→ Page 131). |
| Fuel system | Not vented | Vent fuel system (→ Page 88). |
| ECU | Defective | Contact Service. |

## Engine fires unevenly

| Component | Probable Cause | Task |
|---|---|---|
| Fuel injection equipment | Injector defective | Replace (→ Page 85). |
| Engine wiring | Defective | Check (→ Page 131). |
| Fuel system | Not vented | Vent fuel system (→ Page 88). |
| ECU | Defective | Contact Service. |

## Engine does not reach nominal speed

| Component | Probable Cause | Task |
|---|---|---|
| Fuel supply | Fuel prefilter clogged | Replace (→ Page 95). |
| | Fuel filter clogged | Replace (→ Page 89). |
| Air supply | Air filter clogged | Check signal ring position of service indicator (→ Page 100). |
| Fuel injection equipment | Injector defective | Replace (→ Page 85). |
| Engine wiring | Defective | Check (→ Page 131). |
| Engine | Overloaded | Contact Service. |

TIM-ID: 0000002555 - 002

## Engine speed not steady

| Component | Probable Cause | Task |
|---|---|---|
| Fuel injection equipment | Injector defective | Replace (→ Page 85). |
| Speed sensor | Defective | Replace. |
| Fuel system | Not vented | Vent fuel system (→ Page 88). |
| ECU | Defective | Contact Service. |

## Charge-air temperature too high

| Component | Probable Cause | Task |
|---|---|---|
| Engine coolant | Incorrect coolant concentration | Check. |
| Intercooler | Contaminated | Contact Service. |
| Engine room | Air-intake temperature too high | Check fans and air supply / ventilation ducts. |

## Charge air pressure too low

| Component | Probable Cause | Task |
|---|---|---|
| Air supply | Air filter clogged | Check signal ring position of service indicator (→ Page 100). |
| Intercooler | Contaminated | Contact Service. |
| Exhaust turbocharger | Defective | Contact Service. |

## Coolant leaks on intercooler

| Component | Probable Cause | Task |
|---|---|---|
| Intercooler | Leaking, major coolant discharge | Contact Service. |

## Exhaust gas black

| Component | Probable Cause | Task |
|---|---|---|
| Air supply | Air filter clogged | Check signal ring position of service indicator (→ Page 100). |
| Fuel injection equipment | Injector defective | Replace (→ Page 85). |
| Engine | Overloaded | Contact Service. |

## Exhaust gas blue

| Component | Probable Cause | Task |
|---|---|---|
| Engine oil | Too much oil in engine | Drain engine oil (→ Page 103). |
| | Oil separator or oil preseparator of crankcase breather clogged | • Clean preseparator (→ Page 78).<br>• Replace filter element of oil separator (→ Page 79). |
| Exhaust turbocharger, cylinder head, piston rings, cylinder liner | Defective | Contact Service. |

TIM-ID: 0000002555 - 002

## Exhaust gas white

| Component | Probable Cause | Task |
|---|---|---|
| Engine | Not at operating temperature | Run engine to reach operating temperature. |
| Fuel system | Water in fuel | Drain fuel prefilter (→ Page 92). |
| Intercooler | Leaking | Contact Service. |

TIM-ID: 0000002555 - 002

# 7 Task Description

## 7.1 SOLAS

### 7.1.1 SOLAS shielding as per MTN 5233 – Installation

#### Preconditions

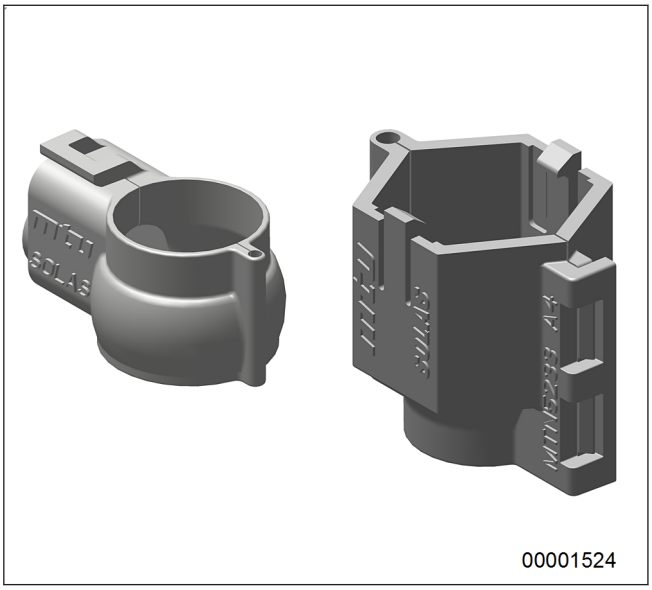
☑ Engine is stopped and starting disabled.

#### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Shield A4 | 735233000100 | 10 |
| Shield A5 | 735233000101 | 14 |
| Shield A7 | 735233000103 | 6 |
| Shield A8 | 735233000104 | 2 |

#### SOLAS shielding – Installation

1. Pinpoint installation location (→ Page 67).
2. Install suitable shielding.
3. Press shielding until locked.



00001524

TIM-ID: 0000010550 - 003

## 7.1.2 SOLAS shielding – Installation

### Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is cooled down to ambient temperature.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Oil filter shield | X00009628 | |
| Fuel filter shield | X00009654 | |

### Installing SOLAS shield on oil filter and fuel filter

1. Pinpoint installation location (→ Page 67).
2. Install suitable shielding.

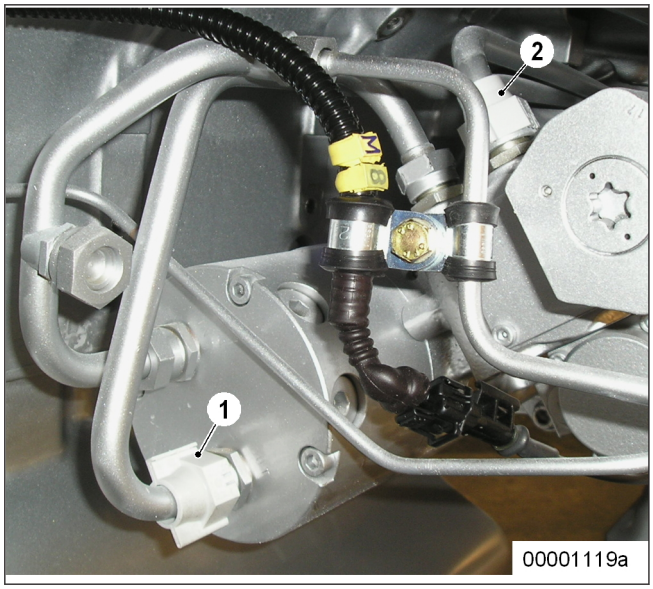
TIM-ID: 0000010702 - 004

## 7.1.3 Installation locations for SOLAS shielding

### General information

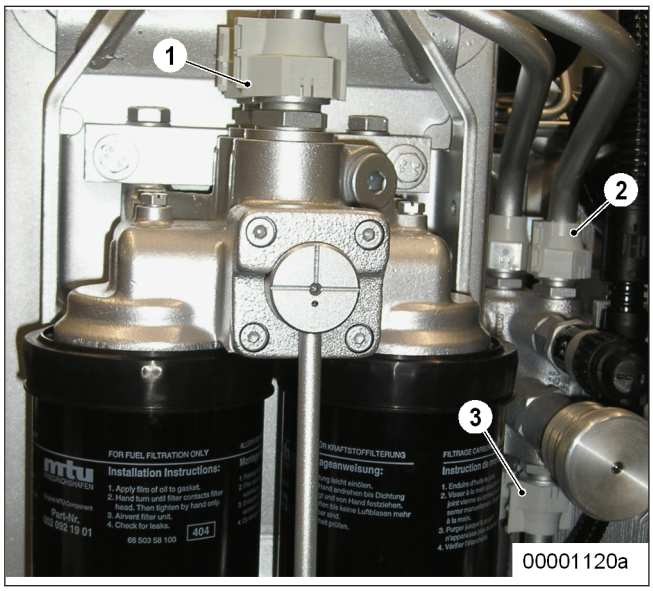
Primarily fit SOLAS shielding as per MTN 5233 (→ Page 65).

### Free end B-side




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (free end, B-side) | Shield (A7) | On fuel delivery pump |
| 2 (free end, B-side) | Shield (A7) | On HP fuel pump |

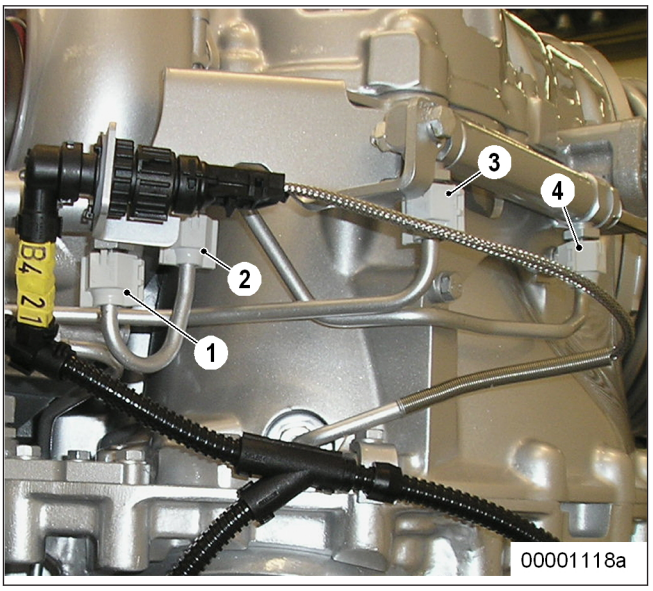
### Free end




TIM-ID: 0000010064 - 005

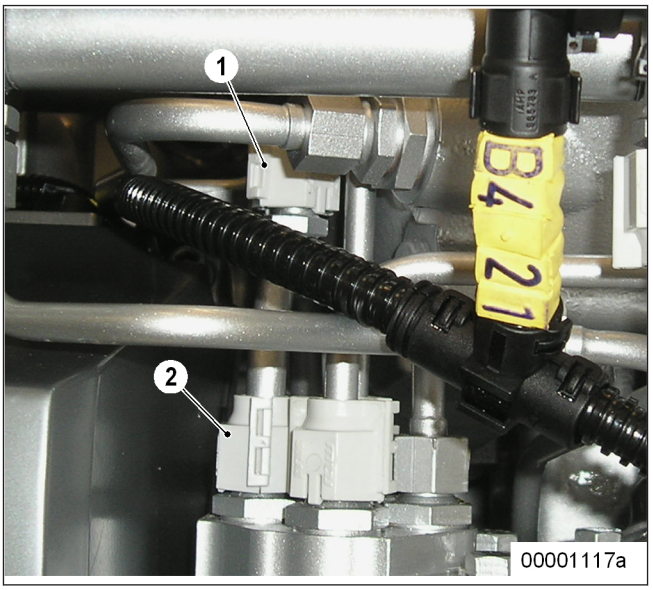
| Item | Type of shielding | Comments |
|---|---|---|
| 1 (free end) | Shield (A8) | On fuel filter |
| 2 (free end) | Shield (A7) | Above fuel priming pump |
| 3 (free end) | Shield (A7) | Below fuel priming pump |

## Driving end A-side




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (Driving end, A-side) | Shield (A5) | On air flap |
| 2 (Driving end, A-side) | Shield (A4) | On brazed-on union |
| 3 (driving end, A-side) | Shield (A5) | On turbocharger flap |
| 4 (driving end, A-side) | Shield (A5) | On turbocharger flap |

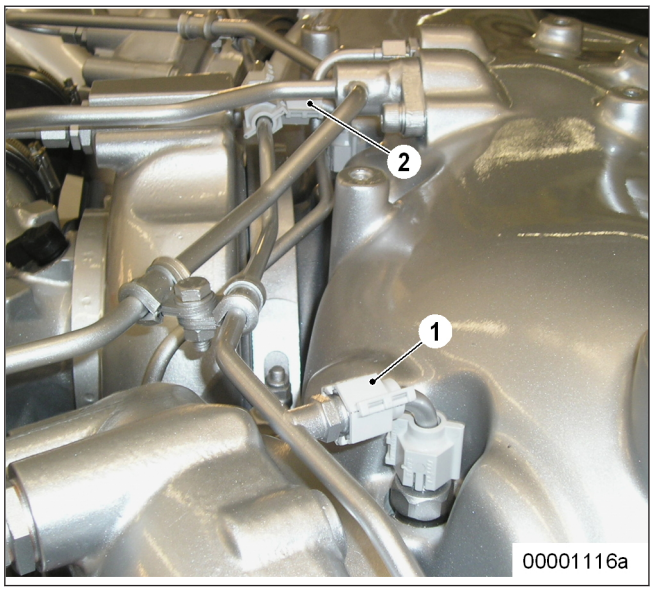
## Driving end A-side




TIM-ID: 0000010064 - 005

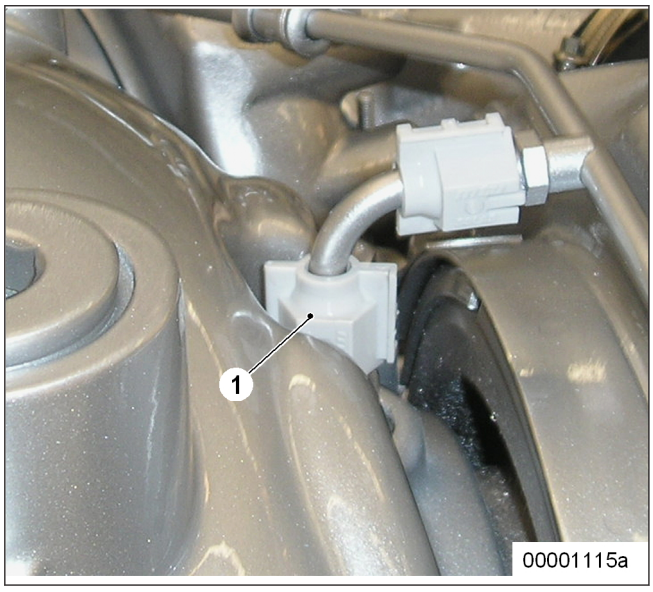
| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end, A-side) | Shield (A5) | To turbocharger lubrication |
| 2 (driving end, A-side) | Shield (A5) | On valve plate |

## Driving end




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end) | Shield (A4) | Turbocharger lubrication, left side |
| 2 (driving end) | Shield (A4) | Turbocharger lubrication, center |

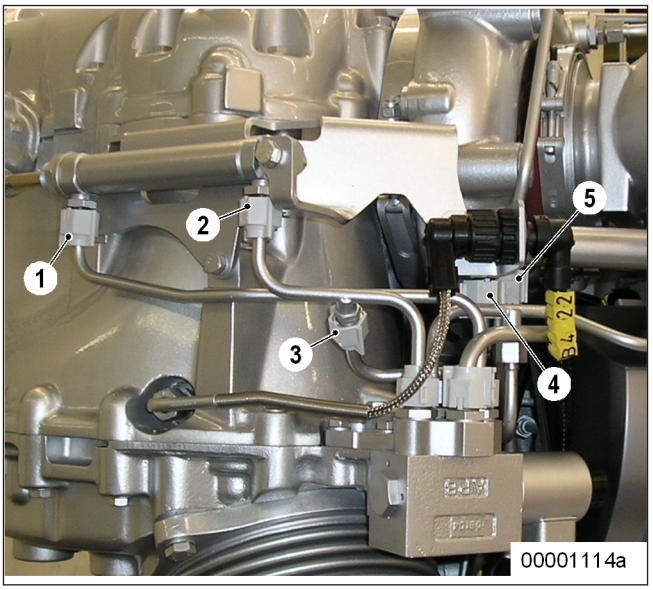
## Driving end




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end) | Shield (A4) | Turbocharger lubrication, right side |

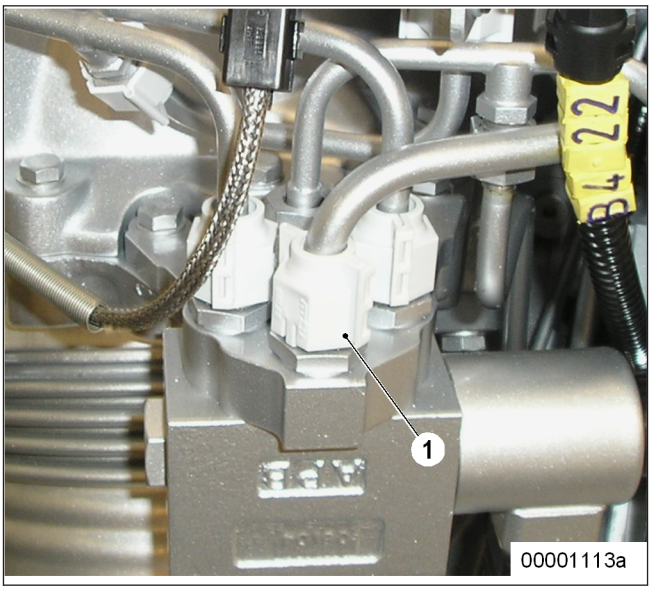
TIM-ID: 0000010064 - 005

## Driving end B-side




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end, B-side) | Shield (A5) | Turbocharger flap |
| 2 (driving end, B-side) | Shield (A5) | Turbocharger flap |
| 3 (driving end, B-side) | Shield (A4) | On brazed-on union |
| 4 (driving end, B-side) | Shield (A5) | On air flap |
| 5 (driving end, B-side) | Shield (A4) | To turbocharger lubrication |

## Driving end B-side



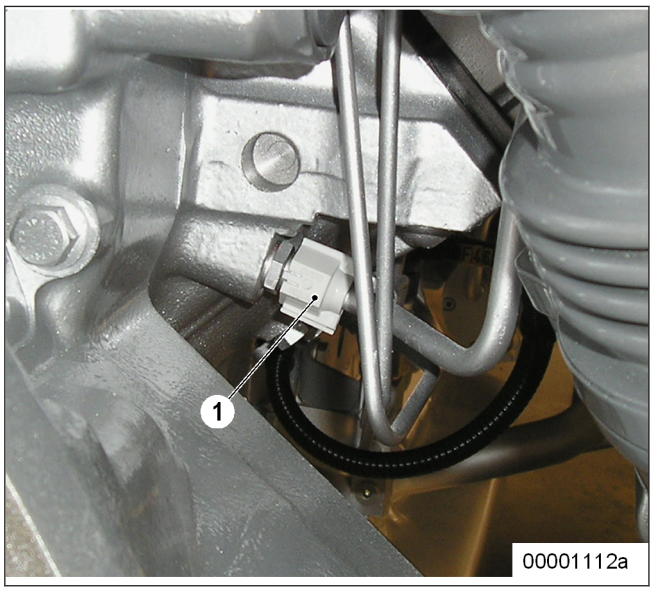

| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end, B-side) | Shield (A5) | On valve plate |

TIM-ID: 0000010064 - 005

## Driving end A-side

| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end, A-side) | Shield (A5) | To flap control |

## Driving end B-side




| Item | Type of shielding | Comments |
|---|---|---|
| 1 (driving end, B-side) | Shield (A5) | To flap control |

TIM-ID: 0000010064 - 005

# 7.2 Engine

## 7.2.1 Engine – Barring manually

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Barring tool | F6783914 | 1 |
| Ratchet | F30006212 | 1 |

DANGER

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

### Engine – Barring manually

1. Fit ratchet with barring tool on barring tool connection at the vibration damper on engine free end.
2. Rotate crankshaft in engine direction of rotation. Apart from the normal compression resistance, there should be no resistance.

Result: If the resistance exceeds the normal compression resistance, contact Service.

TIM-ID: 0000002527 - 002

## 7.2.2 Engine – Barring with starting system

### Preconditions

☑ Clutch is disengaged.

☑ Engine start is disabled.

☑ LOP is accessible and open.

DANGER

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**

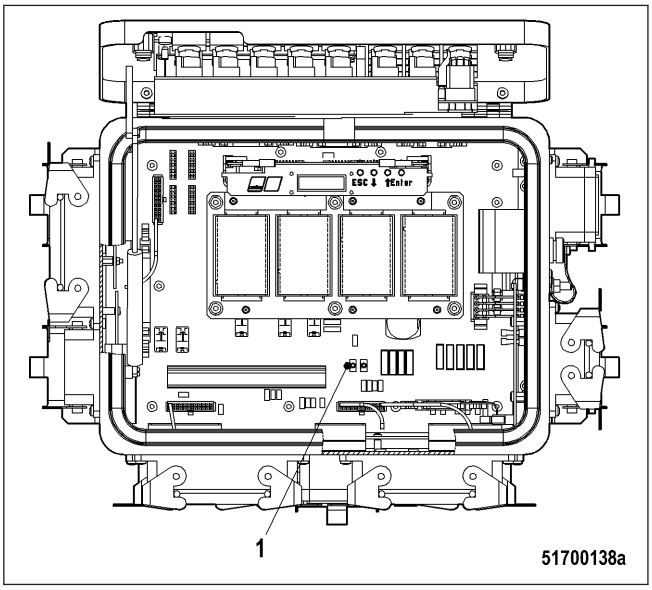
- before barring or starting the engine, ensure that nobody is in the danger zone.
- After working on the engine, check that all protective devices have been reinstalled and all tools removed from the engine.

### Barring

1. Press barring button on the LMB mother-board of the LOP and keep it depressed.

Result: Engine is barred by starter for max. 20 seconds.

2. Release barring button.




TIM-ID: 0000002788 - 001

# 7.3 Cylinder Liner

## 7.3.1 Cylinder liner – Endoscopic examination

### Preconditions

☑ Engine is stopped and starting disabled

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Rigid endoscope | Y20097353 | 1 |

### Preparatory steps

1. Remove cylinder head cover (→ Page 84).
2. Remove injector (→ Page 86).

### Positioning crankshaft at BDC

1. Using barring gear, turn crankshaft until crankshaft journal of the cylinder to be inspected has reached BDC.
2. Insert endoscope into cylinder liner through injector seat.

### Endoscopic examination of cylinder liner

| Findings | Action |
|---|---|
| • Thin carbon coating on circumference of carbon scraper ring<br>• Slight localized additive deposits at top edge<br>• Localized smooth areas on bottom edge<br>• Carbon deposits on circumference in clearance between top piston ring and bottom edge of carbon scraper ring<br>• First signs of marks left by top piston ring<br>• Bright mark on entire circumference<br>• Consistent honing pattern without objections<br>• First signs of marks left by lower cooling bores<br>• Running pattern seems darker | No action required |
| • Dark areas with even or varying degrees of discoloration<br>• Beginning and end of the discoloration are not sharply defined and do not cover the entire stroke area<br>• Dark areas in the upper section of the cooling bore, remaining circumference without objections<br>• Piston rings without objections | Further endoscopic examination required as part of maintenance work |
| • On the entire circumference, apart from light areas of discoloration (that do not impair operation) clearly darker stripes that start at the top piston ring<br>• Heat discoloration in the direction of stroke and honing pattern damage<br>• Heat discoloration of piston rings | Cylinder liner must be replaced; Service must be contacted |

1. Compile endoscopy report using the table.
2. Use technical terms for description of the liner surface (→ Page 76).
3. Depending on findings:
   - do not take any action or
   - carry out a further endoscopic examination as part of maintenance work or
   - contact Service; cylinder liner must be replaced.

TIM-ID: 0000000015 - 013

## Final steps

1. Install injector (→ Page 86).
2. Install cylinder head cover (→ Page 84).

TIM-ID: 0000000015 - 013

## 7.3.2 Cylinder liner – Instructions and comments on endoscopic and visual examination

### Terms used for endoscopic examination

Use the terms listed below to describe the condition of the cylinder-liner surface in the endoscopic examination report.

| Findings | Measure |
|---|---|
| Minor dirt scores | Minor dirt scores can occur during the assembly of a new engine (honing products, particles, broken-off burrs). Removed cylinders clearly show such scoring on the running surface under endoscope magnification. Cannot be felt with the fingernail.<br>Findings not critical. |
| Single scores | Clearly visible scores caused by hard particles. They usually start in the TDC area and cross through the hone pattern in the direction of stroke.<br>Findings not critical. |
| Scored area | These areas consist of scores of different length and depth next to one another. In most cases, they are found at the 6-o'clock and 12-o'clock positions (inlet/exhaust) along the transverse engine axis.<br>Findings not critical. |
| Smoothened area | Smoothened areas are on the running surface but almost the whole honing pattern is still visible. Smoothened areas appear brighter and more brilliant than the surrounding running surface.<br>Findings not critical. |
| Bright area | Bright areas are on the running surface and show local removal of the honing pattern. Grooves from honing process are not visible any more. |
| Discoloration | This is caused by oxidation (surface discoloration through oil or fuel) and temperature differences around the liner. It appears rather darker within the honed structure in contrast to the bright metallic running surface. The honing pattern is undisturbed. Discolorations extend in stroke direction and may be interrupted.<br>Findings not critical. |
| Corrosion fields / spots | Corrosion fields / spots result from water (condensed water) with the valves in the overlap (open) position. They are clearly visible due to the dark color of the honing groove bottom.<br>This corrosion is not critical unless there is corrosion pitting. |
| Black lines | Black lines are a step towards heat discoloration. They are visible as a clear discoloration from TDC to BDC in the running surface and the start of localized damage to the honing pattern.<br>Cylinder liners with a large number of black lines around the running surface have limited service life and should be replaced. |

TIM-ID: 0000000014 - 013

| Findings | Measure |
|---|---|
| Burn mark | This is caused by a malfunction in the liner / ring tribosystem. Usually they run over the whole ring-travel area (TDC/BDC), starting at the first TDC-ring and becoming more visible from the second TDC-ring 2 onwards and less pronounced from TDC-ring 1. The honing pattern is usually no longer visible and displays a clearly defined (straight) edge to the undisturbed surface. The damaged surface is usually discolored. The circumferential length varies.<br>Liners with burn marks, or heat discoloration, starting in TDC ring 1 have to be replaced. |
| Seizure marks, scuffing | Irregular circumference lengths and depths. Can be caused either by the piston skirt or the piston crown. Material deposits on the liner (smear), heavy discoloration. Severe, visible scoring.<br>Replace liner. |

## Evaluation of findings and further measures

The findings in the start phase of oxidation discoloration and heat discoloration are similar. A thorough investigation and compliance with the above evaluation criteria allow an unambiguous evaluation. To avoid unnecessary disassembly work, it is recommended that another inspection be carried out after further operation of the engine.

TIM-ID: 0000000014 - 013

# 7.4 Crankcase Breather

## 7.4.1 Crankcase breather – Cleaning oil pre-separator element

### Preconditions

☑ Engine is stopped and starting disabled.

**WARNING**

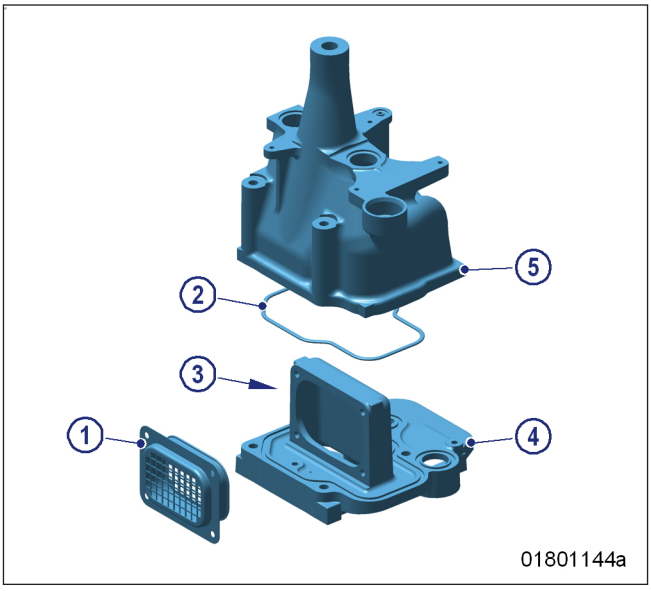
Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

**WARNING**

Compressed air
**Risk of injury!**
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

### Crankcase breather – Cleaning oil pre-separator element

1. Remove cover (5) from housing (4).
2. Take off oil pre-separator element (1), gasket (3) and O-ring (2).
3. Wash oil pre-separator element (1) and housing (4) in fuel and blow out with compressed air.
4. Moisten oil pre-separator element (1) with engine oil.
5. Position oil pre-separator element (1) with new gasket (3) and O-ring (2) on housing (4) and install cover (5).
6. Clean further oil pre-separator elements in the same way.




TIM-ID: 0000011545 - 004

## 7.4.2 Crankcase breather – Oil separator replacement, diaphragm check and replacement

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

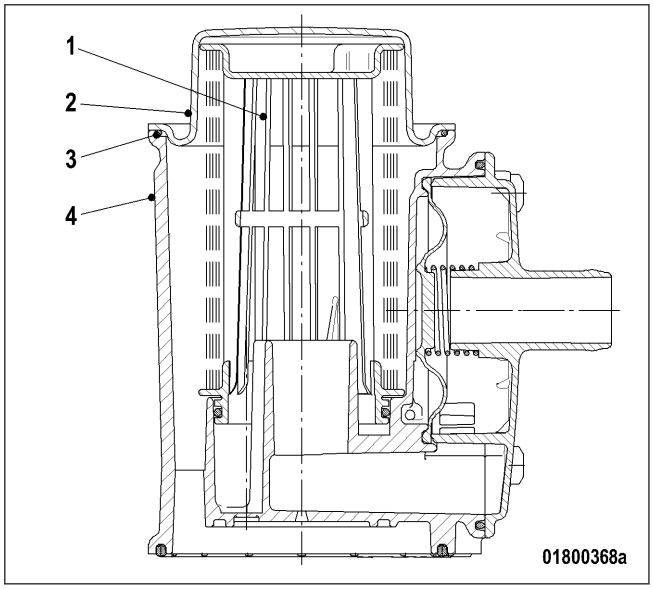
| Designation / Use | Part No. | Qty. |
|---|---|---|
| Torque wrench, 6-50 Nm | F30027336 | 1 |
| Ratchet adapter | F30027340 | 1 |
| Filter element | (→ Spare Parts Catalog) | |
| Diaphragm | (→ Spare Parts Catalog) | |
| O-ring | (→ Spare Parts Catalog) | |

WARNING

Hot oil.
Oil can contain combustion residues which are harmful to health.
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

### Replacing filter element of oil separator

1. Remove cover (2) with O-ring (3).
2. Remove filter element (1) from housing (4).
3. Insert new filter element into housing (4) ensuring correct installation position, and fit cover (2) with new O-ring.




4. Tighten screws of cover (2) to specified tightening torque.

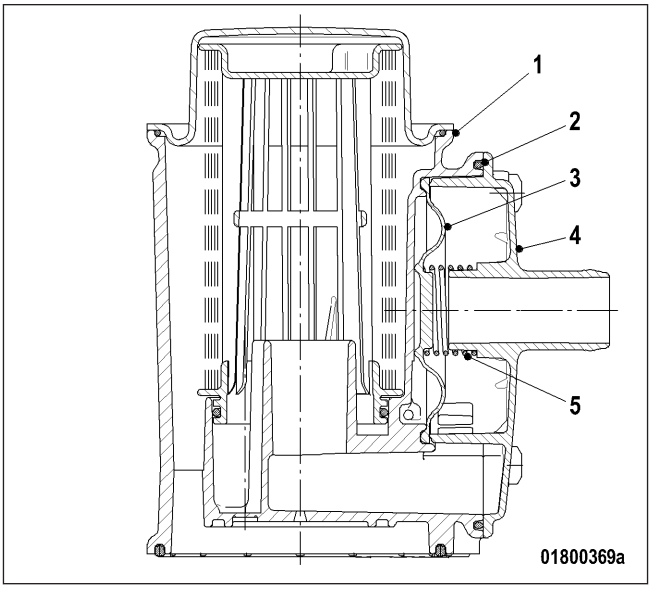
| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Screw | | Tightening torque | | 6 Nm + 2 Nm |

5. Replace filter elements of further oil separators in the same way.

TIM-ID: 0000003491 - 004

## Checking diaphragm

1. Remove cover (4).
2. Take off spring (5), seal (2) and diaphragm (3).
3. Check diaphragm (3) for damage.
4. Fit new diaphragm if used one is damaged.
5. Mount diaphragm (3) on housing (1).
6. Install new seal (2) and spring (5) together with cover (4).




7. Tighten screws of cover (4) to specified tightening torque.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Screw | | Tightening torque | | 6 Nm + 2 Nm |

8. Check diaphragms in further oil separators in the same way.

TIM-ID: 0000003491 - 004

# 7.5 Valve Drive

## 7.5.1 Valve clearance – Check and adjustment

### Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine coolant temperature is max. 40 °C.

☑ Valves are closed.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Feeler gauge | Y4345893 | 1 |
| Barring tool | F6783914 | 1 |
| Ratchet | F30006212 | 1 |
| Double box wrench | F30002800 | 1 |
| Angular screw driver | F30002816 | 1 |
| Socket wrench | F30030450 | 1 |
| Torque wrench, 10-60 Nm | F30510423 | 1 |

### Preparatory steps

1. Remove air filter (→ Page 99).
2. Remove cylinder head cover (→ Page 84).

### Positioning A1 piston at TDC

1. Remove cable from sensor B13 (→ Page 27).
2. Remove sensor B13.
3. Using ratchet and barring tool, rotate crankshaft in engine direction of rotation until the marking on the flywheel is aligned with the center of the sensor seat.

### Checking valve clearance at two crankshaft positions

1. Check TDC position of piston in cylinder A1:
   - If the rocker arms are unloaded on cylinder A1, the piston is in firing TDC.
   - If the rocker arms are loaded on cylinder A1, the piston is in overlap TDC.
2. Check valve clearance with cold engine:
   - Inlet (E) = 0.3 mm;
   - Exhaust (A) = 0.4 mm.
3. Check all valve clearances at two crankshaft positions (firing TDC and overlap TDC) according to the table below.

| 8V2000 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Position | Cylinder | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Firing TDC in cylinder A1 | Bank A | E A | - A | E - | - A | | | | | |
| | Bank B | E - | E - | - - | - A | | | | | |
| Overlap TDC in cylinder A1 | Bank A | - - | E - | - A | E - | | | | | |
| | Bank B | - A | - A | E A | E - | | | | | |
| “E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted | | | | | | | | | | |

TIM-ID: 0000004363 - 003

| 10V2000 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Position | Cylinder | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Firing TDC in cylinder A1 | Bank A | E A | - - | - - | - A | E - | | | | |
| | Bank B | E - | - - | - A | E A | E - | | | | |
| Overlap TDC in cylinder A1 | Bank A | - - | E A | E A | E - | - A | | | | |
| | Bank B | - A | E A | E - | - - | - A | | | | |
| “E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted | | | | | | | | | | |
| 12V2000 | | | | | | | | | | |
| Position | Cylinder | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Firing TDC in cylinder A1 | Bank A | E A | E - | - A | E - | - A | - - | | | |
| | Bank B | E - | - - | - A | E - | E A | - A | | | |
| Overlap TDC in cylinder A1 | Bank A | - - | - A | E - | - A | E - | E A | | | |
| | Bank B | - A | E A | E - | - A | - - | E - | | | |
| “E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted | | | | | | | | | | |
| 16V2000 | | | | | | | | | | |
| Position | Cylinder | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Firing TDC in cylinder A1 | Bank A | E A | - A | - A | E - | - A | E - | - - | - - | |
| | Bank B | E - | - A | - - | E - | E A | E - | E A | - A | |
| Overlap TDC in cylinder A1 | Bank A | - - | E - | E - | - A | E - | - A | E A | E A | |
| | Bank B | - A | E - | E A | - A | - - | - A | - - | E - | |
| “E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted | | | | | | | | | | |
| 18V2000 | | | | | | | | | | |
| Position | Cylinder | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Firing TDC in cylinder A1 | Bank A | E A | E - | - A | E - | - A | - - | - A | - - | - - |
| | Bank B | - A | - A | - - | E A | - - | E A | E - | E A | E - |
| Overlap TDC in cylinder A1 | Bank A | - - | - A | E - | - A | E - | E A | E - | E A | E A |
| | Bank B | E - | E - | E A | - - | E A | - - | - A | - - | - A |
| “E” = inlet valve clearance adjustment permitted, “A” = exhaust valve clearance adjustment permitted | | | | | | | | | | |

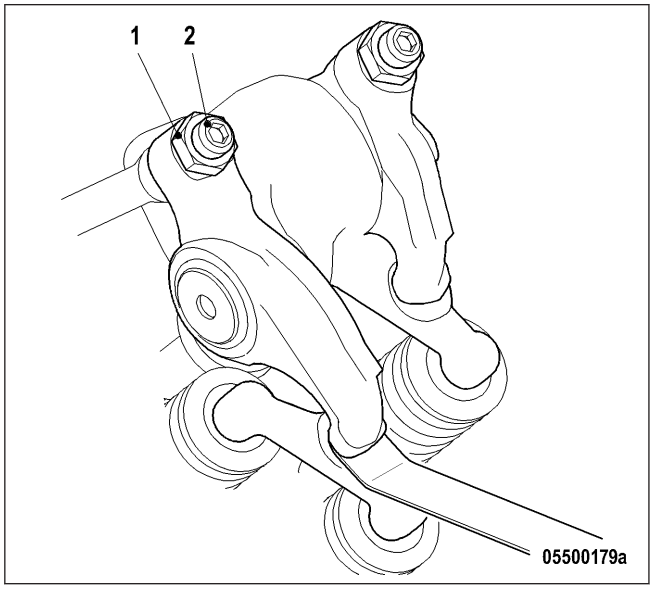
4. Use feeler gauge to determine the distance between valve bridge and rocker arm.
5. If the deviation from the reference value exceeds 0.1 mm, adjust valve clearance.

TIM-ID: 0000004363 - 003

## Valve clearance adjustment

1. Loosen locknut (1) and unscrew adjusting screw (2) by a few threads.
2. Insert feeler gauge between valve bridge and rocker arm.
3. Readjust adjusting screw (2) so that the feeler gauge just passes through the gap.
4. Tighten locknut (1) with torque wrench to the prescribed tightening torque of 50 Nm while holding the adjusting screw (2) with screwdriver.
5. Insert feeler gauge between valve bridge and rocker arm to verify that the gauge just passes through the gap.

Result: If not, adjust valve clearance.




## Final steps

1. Install sensor B13.
2. Connect cable to sensor B13.
3. Remove barring tool.
4. Install cylinder head cover (→ Page 84).
5. Install air filter (→ Page 99).

TIM-ID: 0000004363 - 003

## 7.5.2 Cylinder-head cover – Removal and installation

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Centering device | F6783025 | 1 |
| Gasket | (→ Spare Parts Catalog) | |

### Preparatory steps

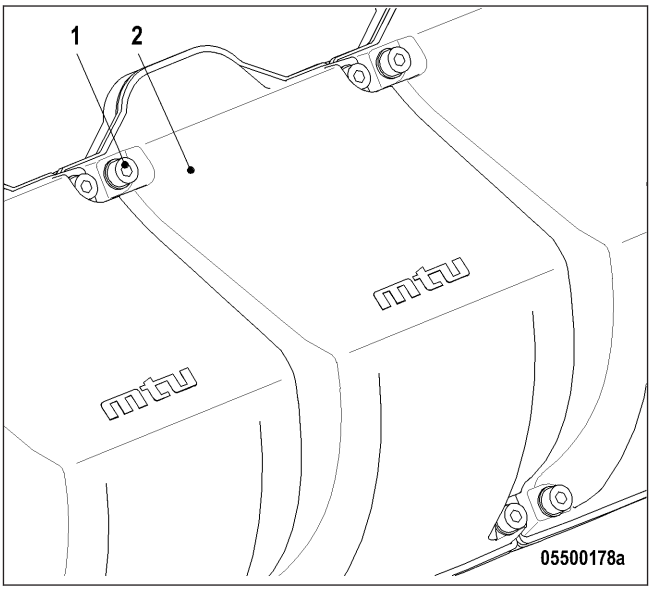
1. Remove air filter (→ Page 99).
2. Remove intake housing.

### Cylinder-head cover – Removal and installation

1. Remove screws (1).
2. Remove cylinder-head cover (2) with gasket from cylinder head.
3. Clean mating faces.
4. Check condition of gasket of cylinder-head cover.

Result: Replace damaged gasket(s).

5. Center cylinder-head cover (2) with centering device.
6. Use torque wrench to tighten screws (1) to specified torque 20 Nm.




### Final steps

1. Install air filter (→ Page 99).
2. Install intake housing.
3. Check cylinder-head covers for leaks.

TIM-ID: 0000004470 - 001

# 7.6 Injection Valve / Injector

## 7.6.1 Injector – Replacement

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Injector | (→ Spare Parts Catalog) | |

### Remove injector and install new one.

▶ (→ Page 86)

TIM-ID: 0000004642 - 002

## 7.6.2 Injector – Removal and installation

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Socket wrench | 0005896803/00 | 1 |
| Puller | F6790629 | 1 |
| Double box wrench | F30011450 | 1 |
| Open end wrench bit | F30025897 | 1 |
| Box wrench adapter | F30451199 | 1 |
| Alignment device | F6790507 | 1 |
| Grease (Kluthe Hakuform 30-10/Emulgier) | X00029933 | 1 |
| Engine oil | | |

WARNING

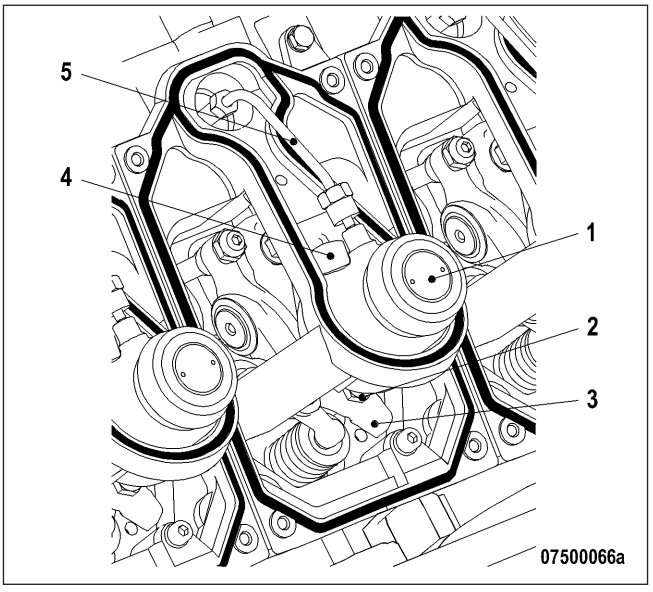
Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Preparatory steps

1. Close fuel supply to engine.
2. Remove cylinder head cover (→ Page 84).

### Removing injector

1. Remove HP line (5) using socket wrench.
2. Disconnect injector cable (4).
3. Remove screw (2).
4. Take off hold-down clamp (3).
5. Remove injector (1) with puller.
6. Remove O-rings from injector.
7. Mask all connections and bores or seal with suitable plugs.




TIM-ID: 0000004650 - 002

## Installing injector

1. Remove all plugs before installation.
2. Fit new O-rings onto injector and coat with grease.
3. Fit new sealing ring with grease on injector, ensuring correct installation position of sealing ring.
4. Clean sealing surface on cylinder head and protective sleeve.
5. Insert injector (1) in cylinder head, ensuring that it is correctly aligned with the HP line connection.
6. Fit hold-down clamp (3) in correct installation position, coat screw (2) with engine oil.
7. Screw in screw (2) and tighten by hand.
8. Coat thread and sealing cone of HP line (5) and injector (1) with engine oil.
9. Align injector (1) and HP line (5) with alignment device.
10. Connect HP line (5) to HP accumulator and tighten by hand.
11. Connect HP line (5) to injector (1) and tighten by hand.
12. Tighten screw of hold-down clamp (3) with a box wrench adapter and a torque wrench to specified tightening torque.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Screw | M10 x 85 | Tightening torque | (Engine oil) | 40 Nm + 4 Nm |

13. Use socket wrench and torque wrench to tighten HP line (5) to the specified torque.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| HP fuel line | | Tightening torque | (Engine oil) | 30 Nm + 5 Nm |

14. Attach cable (4).

## Final steps

1. Install cylinder head cover (→ Page 84).
2. Open fuel supply to engine.

TIM-ID: 0000004650 - 002

# 7.7 Fuel System

## 7.7.1 Fuel system – Venting

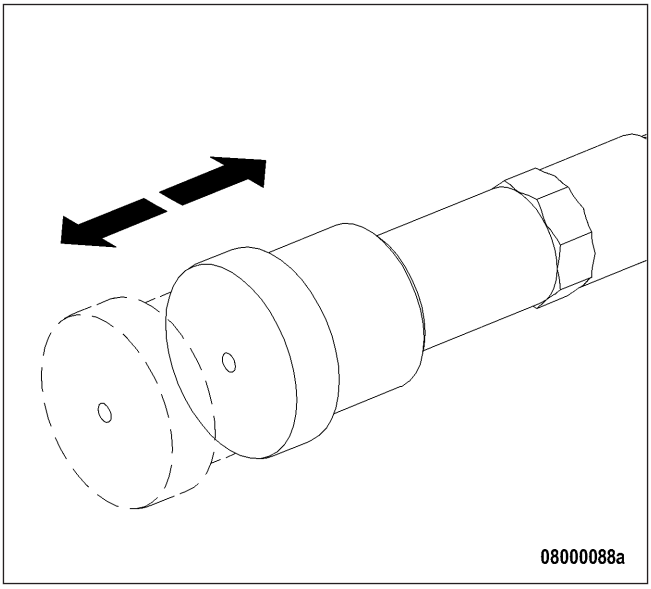
### Preconditions

☑ Engine is stopped and starting disabled.

| WARNING | |
|---|---|
| | Fuels are combustible.<br>**Risk of fire and explosion!**<br>• Avoid open flames, electrical sparks and ignition sources.<br>• Do not smoke. |

### Venting fuel system

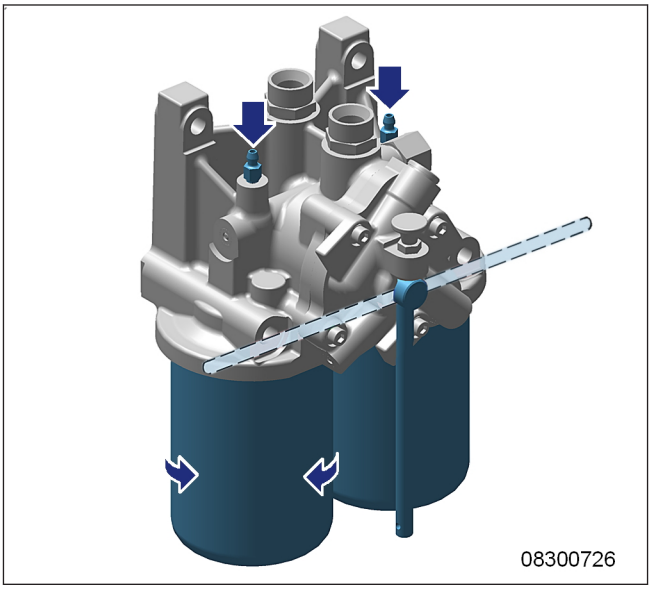
1. Unlock fuel priming pump, unscrew handle.




2. Open vent plugs on filter head.

Note: New version has two threaded vent plugs, old version has four threaded vent plugs.

3. Operate the pump with the handle until fuel without bubbles comes out of the vent plugs and the nipples.
4. Close vent plugs on filter head.
5. Operate the pump with the handle until fuel without bubbles comes out of the nipple.
6. Lock fuel priming pump, screw in handle.




TIM-ID: 0000004716 - 002

# 7.8 Fuel Filter

## 7.8.1 Fuel filter – Replacement

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Oil filter wrench | F30379104 | 1 |
| Diesel fuel | | |
| Easy-change filter | (→ Spare Parts Catalog) | |

DANGER

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

DANGER

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

WARNING

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

WARNING

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

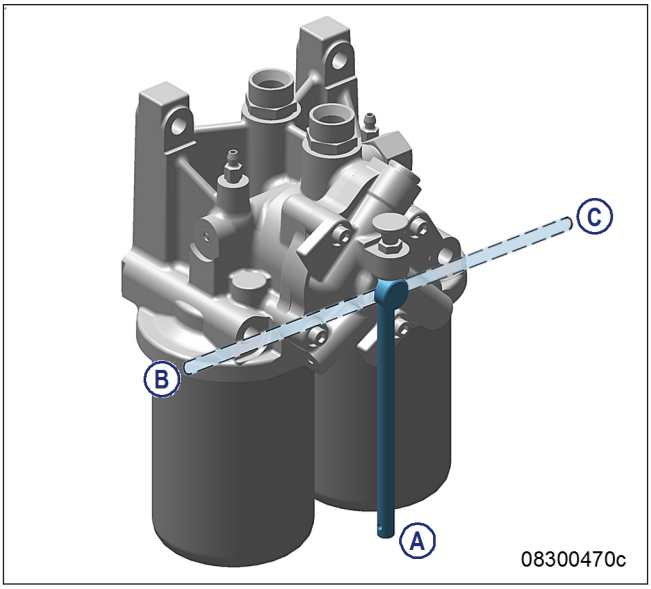
CAUTION

Damage to component.
**Serious damage to plant!**
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

TIM-ID: 0000004914 - 004

## Easy-change fuel filter replacement with the engine stopped

1. Stop engine and disable engine start.
2. Cut out the filter to be replaced.
   - B Left filter cut out
   - C Right filter cut out
3. Remove cut-out easy-change filter using the oil filter wrench.
4. Clean sealing surface on filter head.
5. Check sealing ring of the new easy-change filter and coat it with fuel.
6. Fit SOLAS shield (→ Page 65).
7. Screw on easy-change filter and tighten by hand.
8. Set three-way cock to operating position (A) so that both filters are cut in (operating position).
9. Replace further fuel filters in the same way.
10. Vent fuel system (→ Page 88).

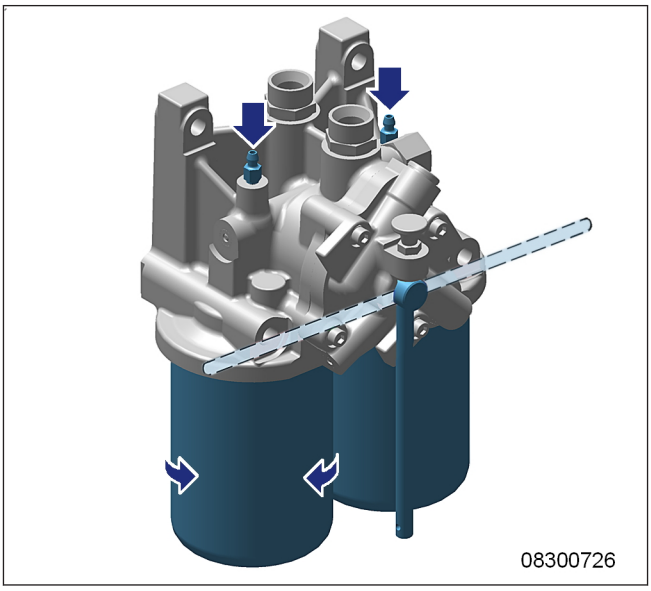



## Easy-change fuel filter replacement with the engine running

1. Cut out the filter to be replaced.
2. Open the threaded vent plugs at the filter head of the cut-out filter and make sure that the fuel filter is not pressurized.

Note: New version has two threaded vent plugs, old version has four threaded vent plugs.

3. Close threaded vent plugs.
4. Remove cut-out easy-change filter using the oil filter wrench.
5. Clean sealing surface on filter head.
6. Check sealing ring of the new easy-change filter and coat it with fuel.
7. Fit SOLAS shield (→ Page 65).
8. Screw on easy-change filter and tighten by hand.
9. Set three-way cock to operating position (both filters cut in).
10. Replace further fuel filters in the same way.




TIM-ID: 0000004914 - 004

## 7.8.2 Fuel prefilter – Differential pressure check and adjustment of gauge

**DANGER**

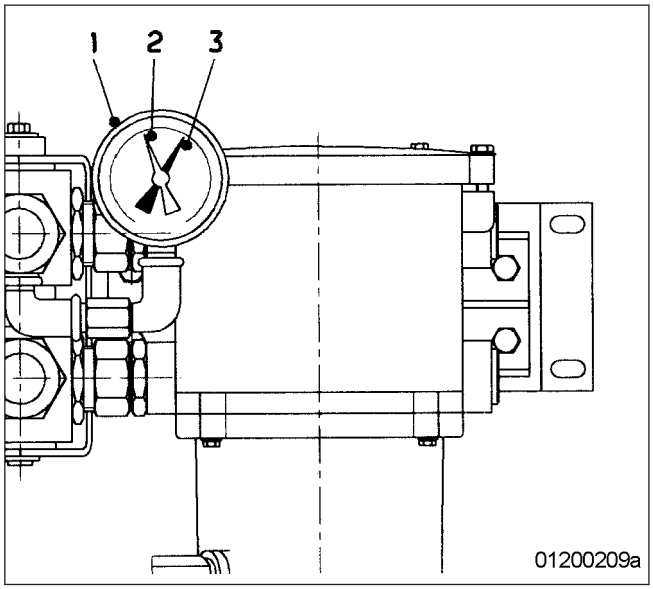
Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### Differential pressure gauge adjustment

1. When installing the new filter element: align adjustable pointer (2) with pressure-indicating pointer (3) of pressure gauge (1).
2. Verify that differential pressure is within the limit.




### Fuel prefilter – Checking differential pressure

1. With the engine running at full load or rated power, read off pressure at gauge (1).
2. If differential pressure as indicated between position of adjustable pointer (2) and pressure indicator of pressure gauge (3) is ≥ 0.3 bar, flush filter element of the cut-in filter (→ Page 93).

TIM-ID: 0000004926 - 003

## 7.8.3 Fuel prefilter – Draining

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

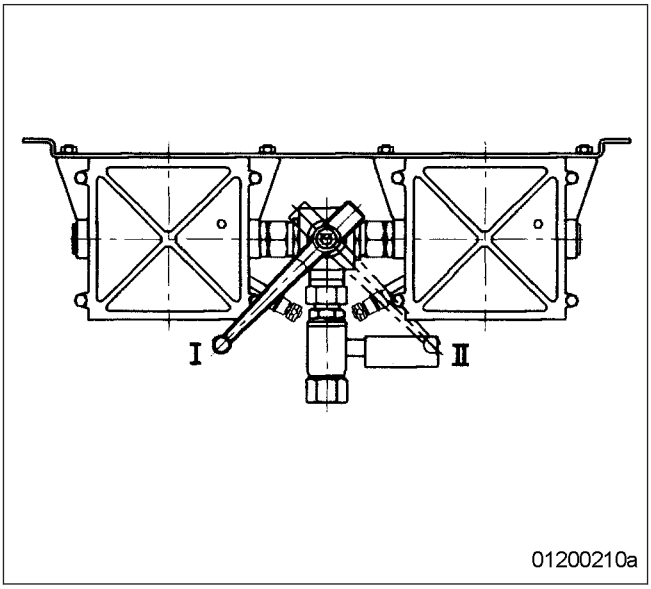
| Designation / Use | Part No. | Qty. |
|---|---|---|
| Diesel fuel | | |
| Seal | (→ Spare Parts Catalog) | |

WARNING

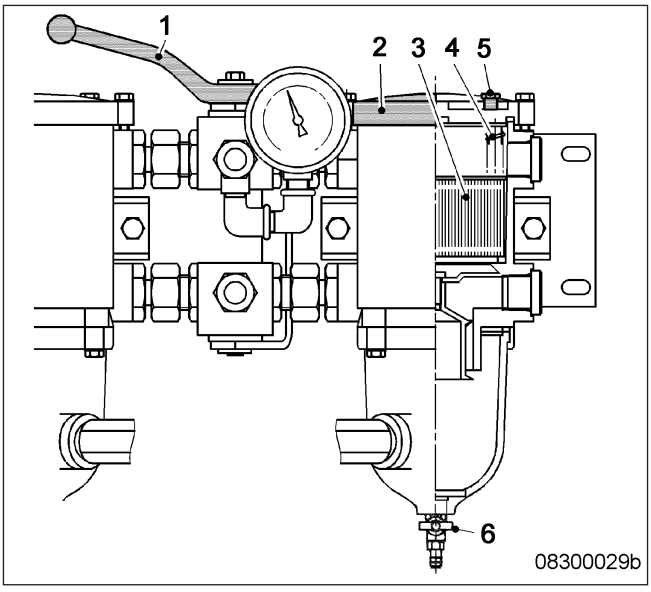
Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Fuel prefilter – Draining

1. Cut out the filter to be drained.
   - I Left filter cut in
   - II Right filter cut in




2. Open threaded vent plug (5) of the filter to be drained.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from the filter until pure fuel emerges.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Fill filter housing with clean fuel.
8. Place new seal in cover (2).
9. Fit cover with gasket and secure it with screws.
10. Cut in the cut-out filter again.
11. Close threaded vent plug (5) when fuel emerges from system.




TIM-ID: 0000004933 - 004

## 7.8.4 Fuel prefilter – Flushing

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Diesel fuel | | |
| Seal | (→ Spare Parts Catalog) | |

**DANGER**

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

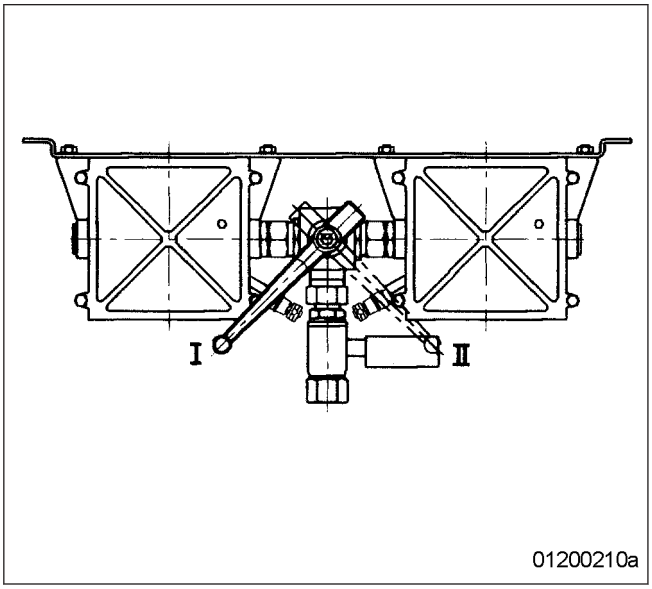
Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### Fuel prefilter – Flushing

1. Switch off contaminated filter.
   - I Left filter cut in
   - II Right filter cut in

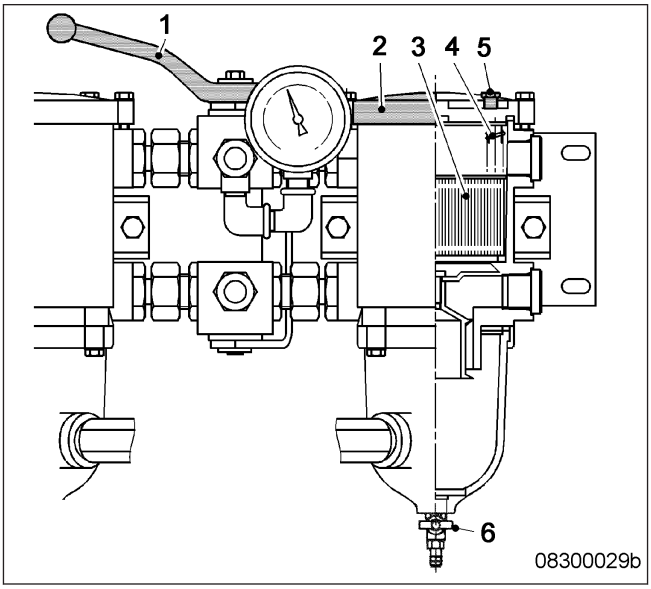



TIM-ID: 0000004939 - 002

2. Open threaded vent plug (5) of the filter to be flushed.
3. Unlock drain valve (6) by pressing toggle, open it and drain fuel.

Result: Fuel flows from filtered side back to the unfiltered side, flushing the filter deposits downwards out of the filter.

4. Close threaded vent plug (5) and drain valve (6).




## Fuel prefilter – Filling with fuel

1. Stop engine (→ Operating Instructions for electronic system ) and disable engine start.
2. Remove screws securing the cover and take off cover (2).
3. Fill filter housing with clean fuel.
4. Place new seal in cover (2).
5. Fit cover with gasket and secure it with screws.
6. Check differential pressure (→ Page 91).

Result: If flushing did not improve differential pressure, fit new filter element in fuel prefilter (→ Page 95).

TIM-ID: 0000004939 - 002

## 7.8.5 Fuel prefilter – Filter element replacement

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

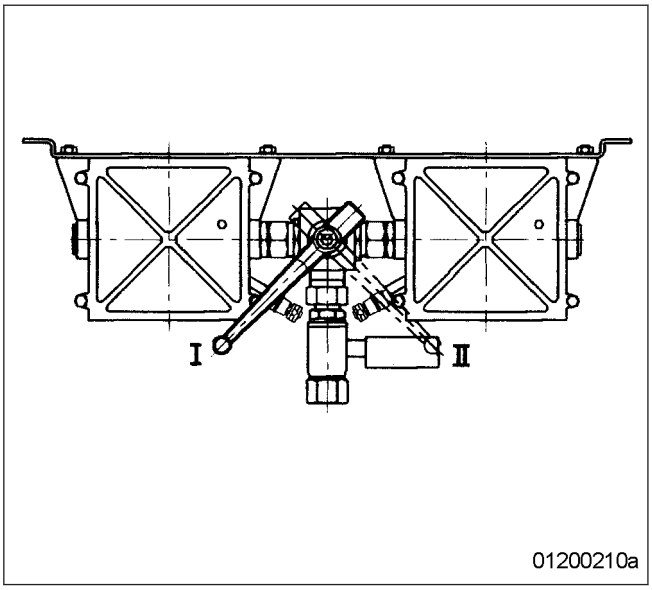
| Designation / Use | Part No. | Qty. |
|---|---|---|
| Diesel fuel | | |
| Filter element | (→ Spare Parts Catalog) | |
| Seal | (→ Spare Parts Catalog) | |

WARNING

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

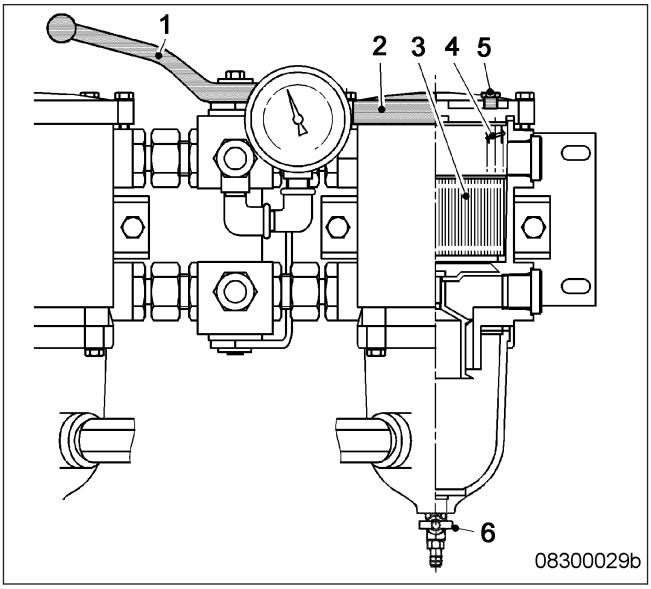
### Replacing filter element

1. Cut out the contaminated filter.
   - I Left filter cut in
   - II Right filter cut in




TIM-ID: 0000004946 - 004

2. Open threaded vent plug (5) of contaminated filter.
3. Unlock drain valve (6) by pressing toggle and open it.
4. Drain water and contaminants from the filter.
5. Close drain valve (6).
6. Remove screws securing the cover and take off cover (2).
7. Remove spring housing (4) and filter element (3).
8. Insert new filter element (3) and spring housing (4).
9. Fill filter housing with clean fuel.
10. Place new seal in cover (2).
11. Fit cover with gasket and secure it with screws.
12. Cut in the cut-out filter again.
13. Close threaded vent plug (5) when fuel emerges.
14. Set adjustable pointer of differential pressure gauge (→ Page 91).




TIM-ID: 0000004946 - 004

# 7.9 Charge-Air Cooling

## 7.9.1 Intercooler – Checking condensate drain line for coolant discharge and obstruction

**DANGER**

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

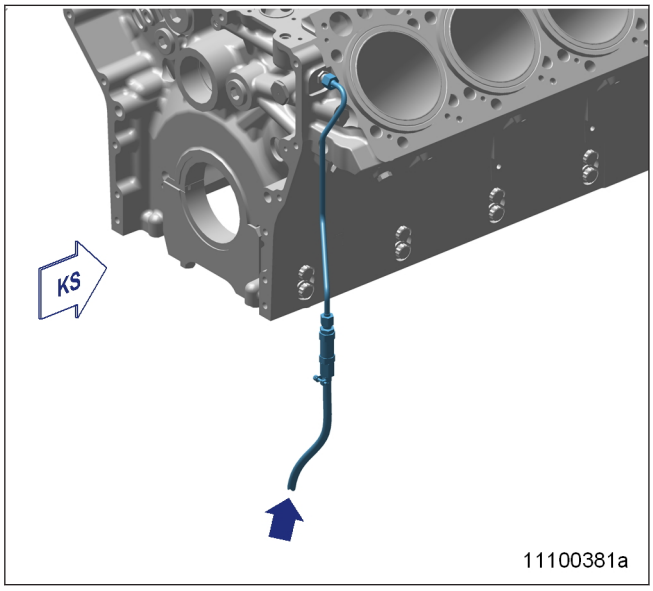
Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

**WARNING**

Compressed air
**Risk of injury!**
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

### Intercooler – Checking condensate drain line for coolant discharge and obstruction

1. Check drain line for water discharge and obstruction when the engine is running idle.
2. If no air emerges, remove condensate drain line and blow out with compressed air.
3. Replace obstructed drain line by new one.
4. Install condensate drain line.
5. If a large amount of coolant is continuously discharged, the intercooler is leaking. Contact Service.




### Emergency measures prior to engine start with a leaking intercooler

1. Remove injectors (→ Page 85).
2. Bar engine manually (→ Page 72).
3. Bar engine with starting system to blow out combustion chambers (→ Page 73).
4. Install injectors (→ Page 86).

TIM-ID: 0000027574 - 003

# 7.10 Air Filter

## 7.10.1 Air filter – Replacement

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Air filter | (→ Spare Parts Catalog) | |

### Air filter – Replacement

1. Remove old air filter and install new air filter (→ Page 99).
2. Reset signal ring of service indicator (→ Page 100).

TIM-ID: 0000005447 - 009

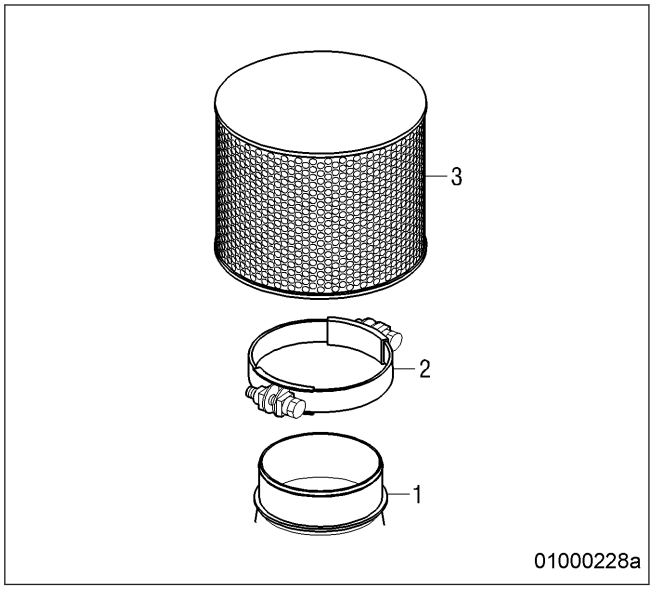
## 7.10.2 Air filter – Removal and installation

### Preconditions

☑ Engine is stopped and starting disabled.

### Air filter – Removal and installation

1. Release clamp (2).
2. Remove air filter (3) and clamp (2) from flange of intake housing (1).
3. Verify that there are no objects in the flange of the intake housing (1) and clean it.
4. Place new air filter (3) with clamp (2) onto intake housing (1).
5. Tighten clamp (2).




TIM-ID: 0000005457 - 005

# 7.11 Air Intake

## 7.11.1 Contamination indicator – Signal ring position check

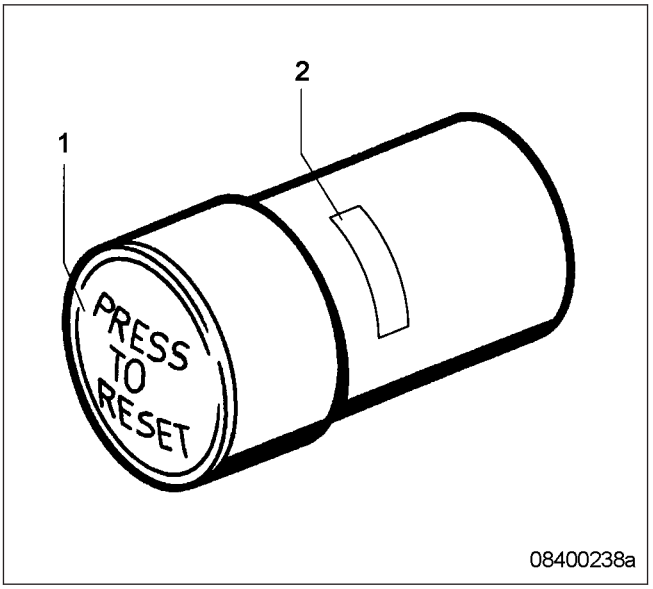
### Preconditions

☑ Engine is stopped and starting disabled.

### Checking signal ring position

1. If the signal ring is completely visible in the control window (2), replace air filter (This is not applicable to your system.).
2. After installation of new filter, press reset button (1).

Result: Engaged piston with signal ring moves back to initial position.




TIM-ID: 0000005484 - 006

# 7.12 Starting Equipment

## 7.12.1 Starter – Condition check

### Preconditions

☑ Engine is stopped and starting disabled.

### Starter – Condition check

1. Check securing screws of starter for secure seating and tighten if required.
2. Check wiring (→ Page 131).

TIM-ID: 0000000905 - 015

# 7.13 Lube Oil System, Lube Oil Circuit

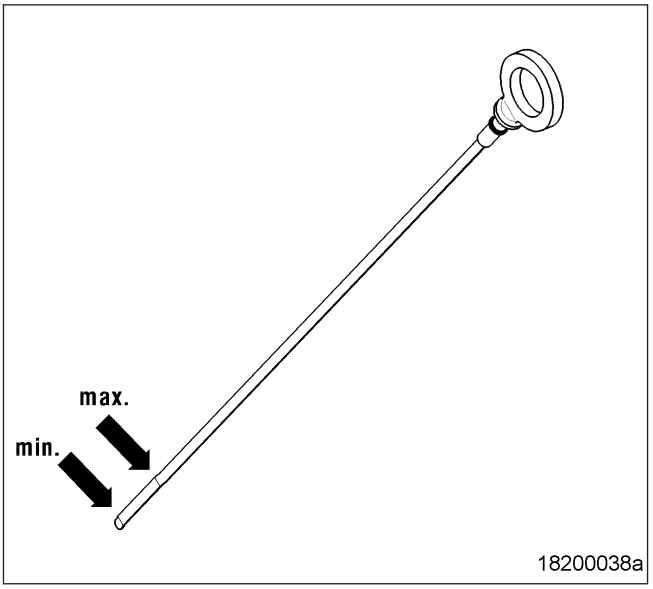
## 7.13.1 Engine oil – Level check

### Preconditions

☑ Engine is stopped and starting disabled.

### Oil level check prior to engine start

1. Withdraw oil dipstick from guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between "min." and "max." marks.
4. Top up to "max." if required (→ Page 103).
5. Insert oil dipstick into guide tube up to the stop.




### Oil level check after the engine is stopped

1. 5 minutes after stopping the engine, remove oil dipstick from the guide tube and wipe it.
2. Insert oil dipstick into guide tube up to the stop, withdraw after approx. 10 seconds and check oil level.
3. Oil level must be between “min.” and "max." marks.
4. Top up to "max." if required (→ Page 103).
5. Insert oil dipstick into guide tube up to the stop.

TIM-ID: 0000000032 - 002

## 7.13.2 Engine oil – Change

### Preconditions

☑ Engine is stopped and starting disabled.

☑ Engine is at operating temperature.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Engine oil | | |

WARNING

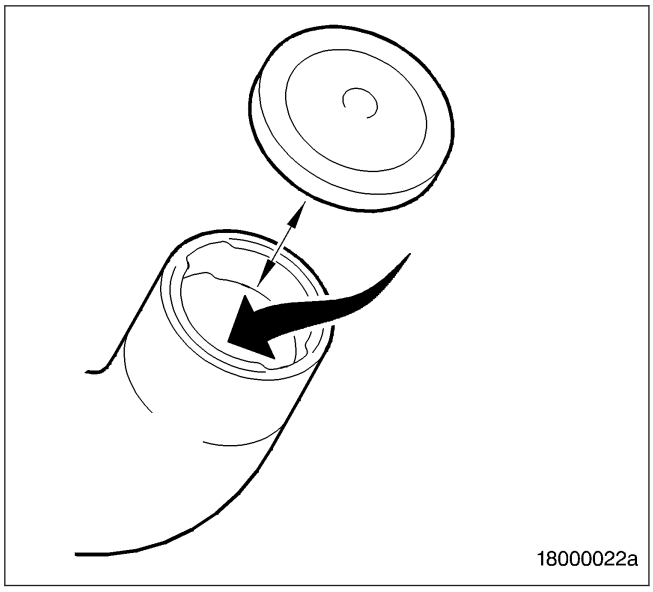
Hot oil.
Oil can contain combustion residues which are harmful to health.
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

### Version with extraction equipment: Extracting engine oil

1. Position a suitable container to drain the engine oil into.
2. Extract all engine oil from oil pan using the extraction equipment.

### Filling with new engine oil

1. Determine amount of engine oil required for oil change (→ Product Summary - Technical Data).
2. Open cover on filler neck.
3. Fill engine oil through filler neck up to “max.” mark on oil dipstick.
4. Close cover on filler neck.
5. Check engine oil level (→ Page 102).
6. After oil change, bar engine with starting system.




TIM-ID: 0000024903 - 001

# 7.14 Oil Filtration / Cooling

## 7.14.1 Engine oil filter – Replacement

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Oil filter wrench | F30379104 | 1 |
| Engine oil | | |
| Oil filter | (→ Spare Parts Catalog) | |

**DANGER**

Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

**WARNING**

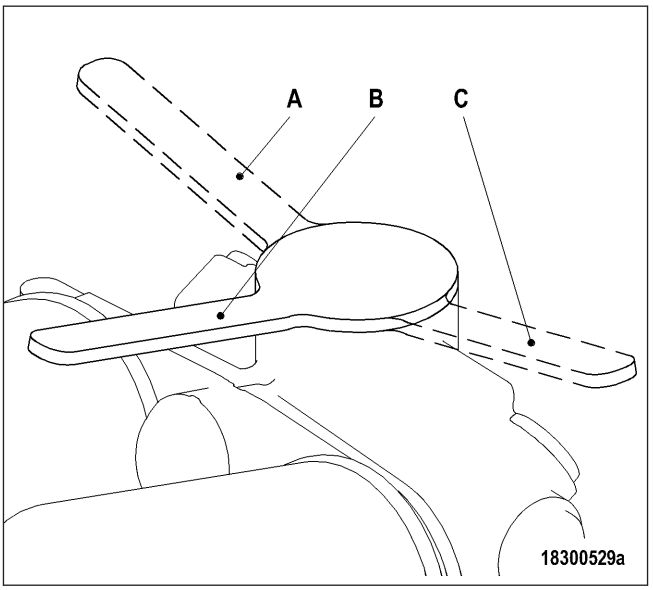
Hot oil.
Oil can contain combustion residues which are harmful to health.
**Risk of injury and poisoning!**
- Wear protective clothing, gloves, and goggles / safety mask.
- Avoid contact with skin.
- Do not inhale oil vapor.

**CAUTION**

Damage to component.
**Serious damage to plant!**
- For filter replacement with the engine running, operate the engine at low engine load.
- The filter which is to be exchanged must be cut out for a brief period only.

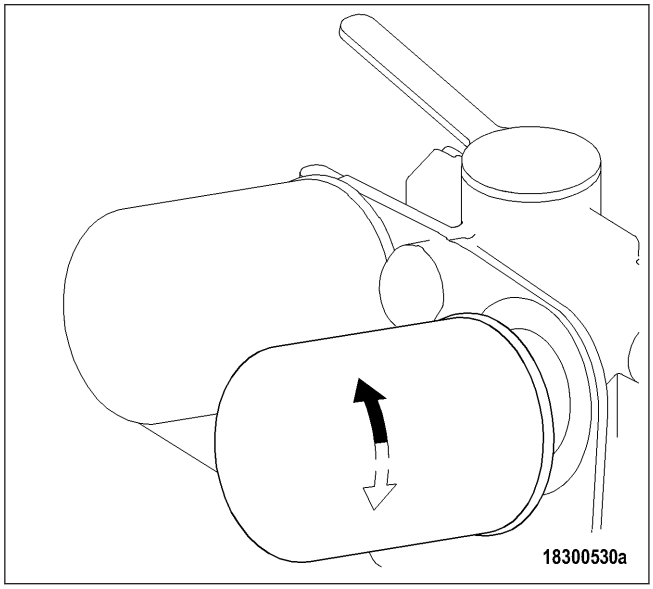
### Oil filter replacement with the engine stopped

1. Stop engine and disable starting
2. Cut out the filter to be replaced.
   - A Right filter cut out
   - B Both filters cut in (operating position)
   - C Left filter cut out




TIM-ID: 0000006369 - 002

3. Remove cut-out oil filter using the oil filter wrench.
4. Clean the sealing surface at the connecting piece.
5. Check condition of the new sealing ring and coat it with oil.
6. Fit the protective cover acc. to SOLAS requirements (→ Page 19).
7. Install and tighten new oil filter by hand.
8. Replace further oil filters in the same way.
9. After each oil change and filter replacement, bar engine with starting system (→ Page 73).
10. Check oil level (→ Page 102).




## Oil filter replacement with the engine running

1. Cut out the filter to be replaced.
2. Remove cut-out oil filter using the oil filter wrench.
3. Clean the sealing surface at the connecting piece.
4. Check condition of the new sealing ring and coat it with oil.
5. Fit the protective cover acc. to SOLAS requirements (→ Page 19).
6. Install and tighten new oil filter by hand.
7. Replace further oil filters in the same way.
8. Check oil level (→ Page 102).

TIM-ID: 0000006369 - 002

## 7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

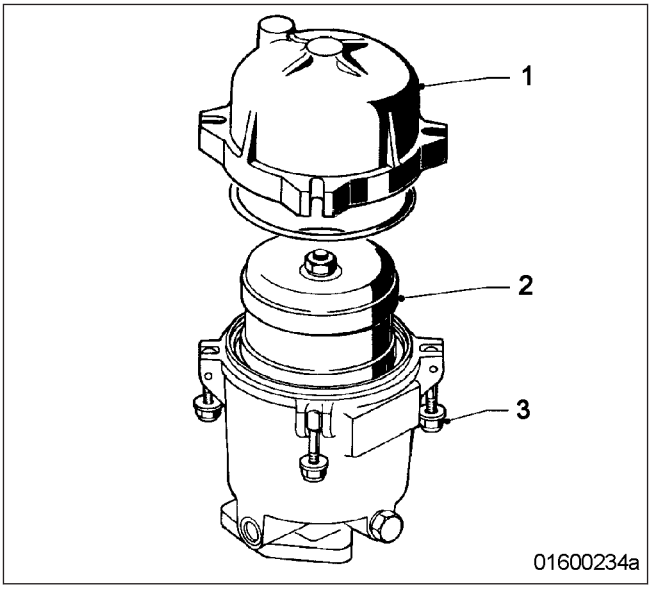
| Designation / Use | Part No. | Qty. |
|---|---|---|
| Strap wrench | F30379104 | 1 |
| Cold cleaner (Hakutex 50) | 50622 | 1 |
| Filter sleeve | (→ Spare Parts Catalog) | |
| O-ring | (→ Spare Parts Catalog) | |
| O-ring | (→ Spare Parts Catalog) | |

WARNING

Compressed air
**Risk of injury!**
- Do not direct compressed-air jet at persons.
- Wear protective goggles / safety mask and ear protectors.

### Centrifugal oil filter – Rotor removal

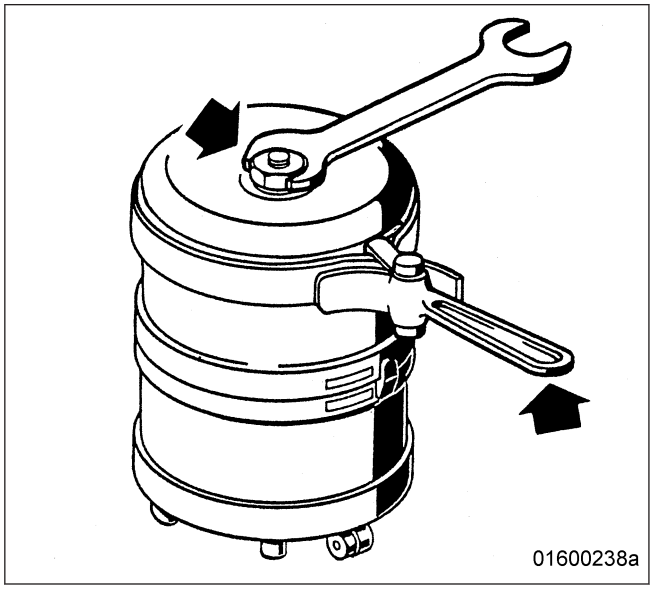
1. Release nuts (3).
2. Remove housing cover (1).
3. Remove complete rotor (2) from housing.



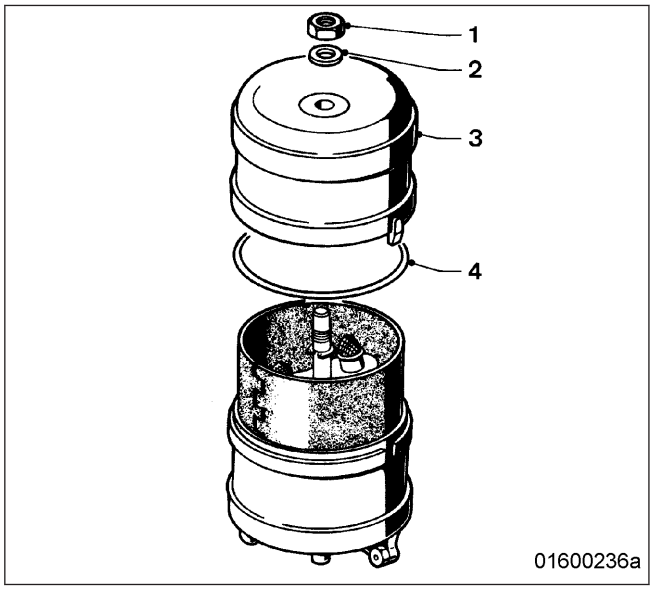

TIM-ID: 0000006418 - 002

## Centrifugal oil filter – Cleaning and filter sleeve replacement

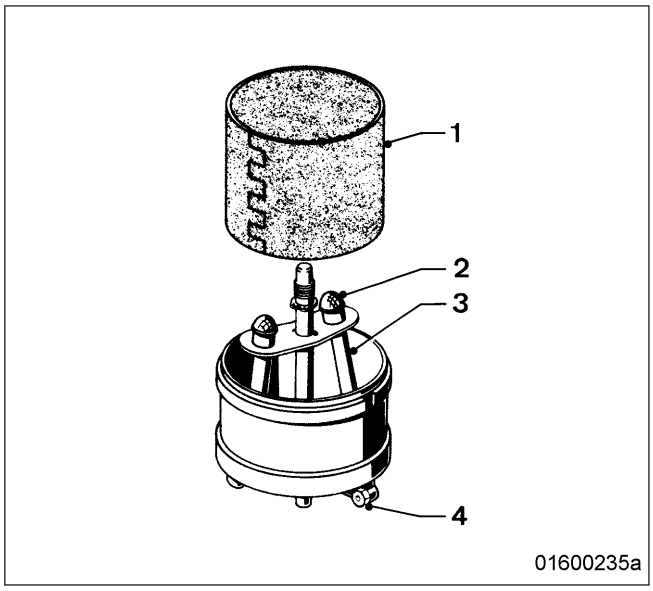
1. Remove nut, holding the rotor with a strap wrench.




2. Remove nut (1), washer (2), rotor cap (3) and sealing ring (4).

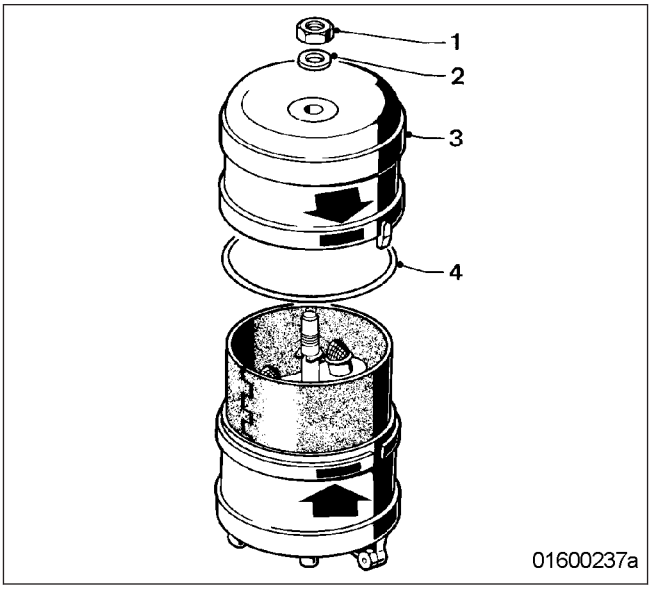



3. Remove sleeve (1).
4. Measure the layer thickness of the oil residue.
5. If maximum layer thickness (25 mm) is exceeded, shorten maintenance interval.
6. Clean rotor components and remove strainers (2).
7. Wash standpipes (3) and nozzles (4) with cleaner, blow out with compressed air.
8. Insert the new filter sleeve with the smooth surface facing the rotor cap.




TIM-ID: 0000006418 - 002

9. Fit new sealing ring (4).
10. Set on rotor cap (3), observe marks.
11. Fit washer (2).



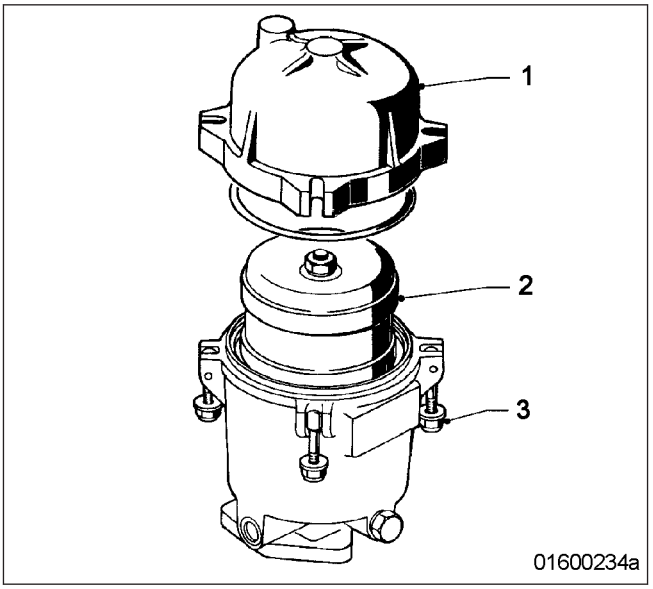

12. Hold rotor (new design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Nut | M18 x 1.5 | Tightening torque | | 10 Nm |

13. Hold rotor (old design) with strap wrench and tighten nut (1) with torque wrench to the specified torque.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Nut | M16 x 1.5 | Tightening torque | | 40 Nm to 50 Nm |

14. Insert complete rotor (2) into the housing and check for ease-of-movement.
15. Set housing cover (1) with new sealing ring onto lower section, observe marks.
16. Tighten nuts (3) crosswise and evenly.

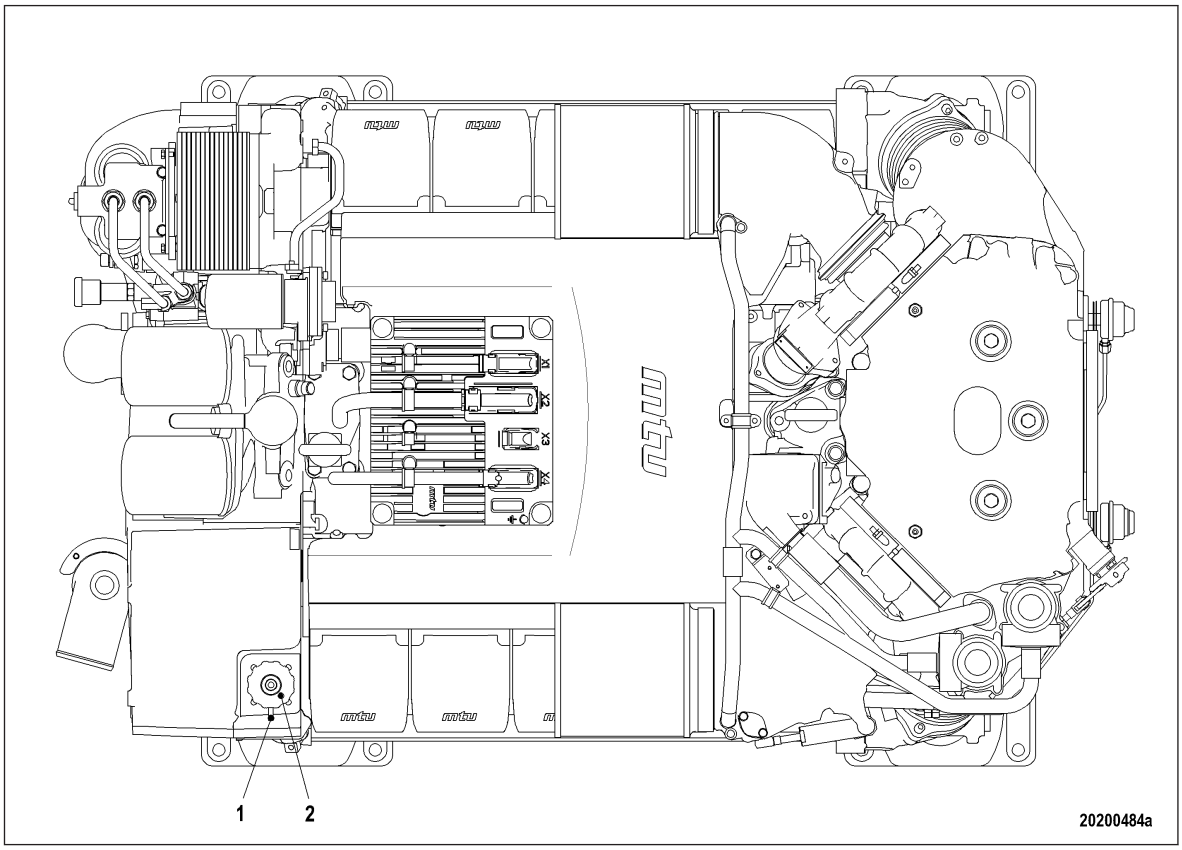



TIM-ID: 0000006418 - 002

# 7.15 Coolant Circuit, General, High-Temperature Circuit

## 7.15.1 Drain and venting points

### 8 V, 10 V

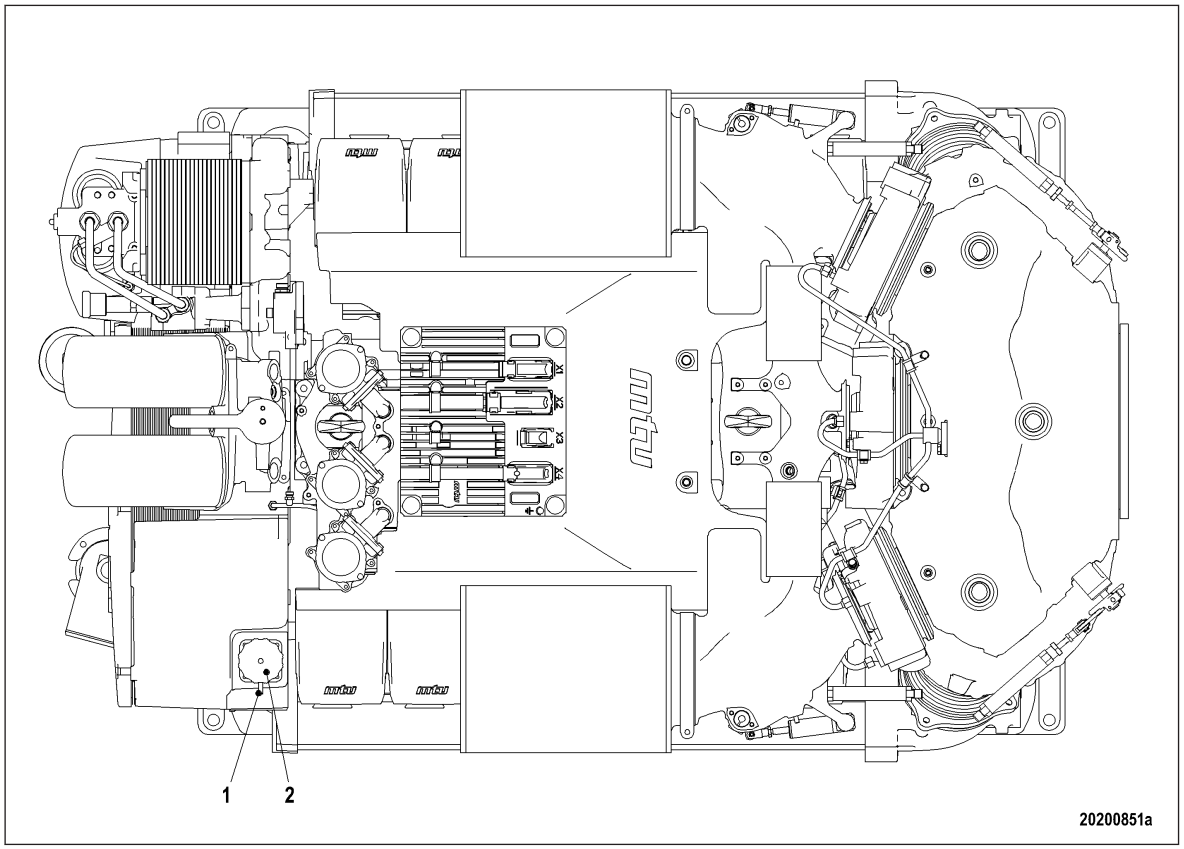



1 Overflow line, expansion tank

2 Filler neck

TIM-ID: 0000006696 - 001

## 12 V, 16 V

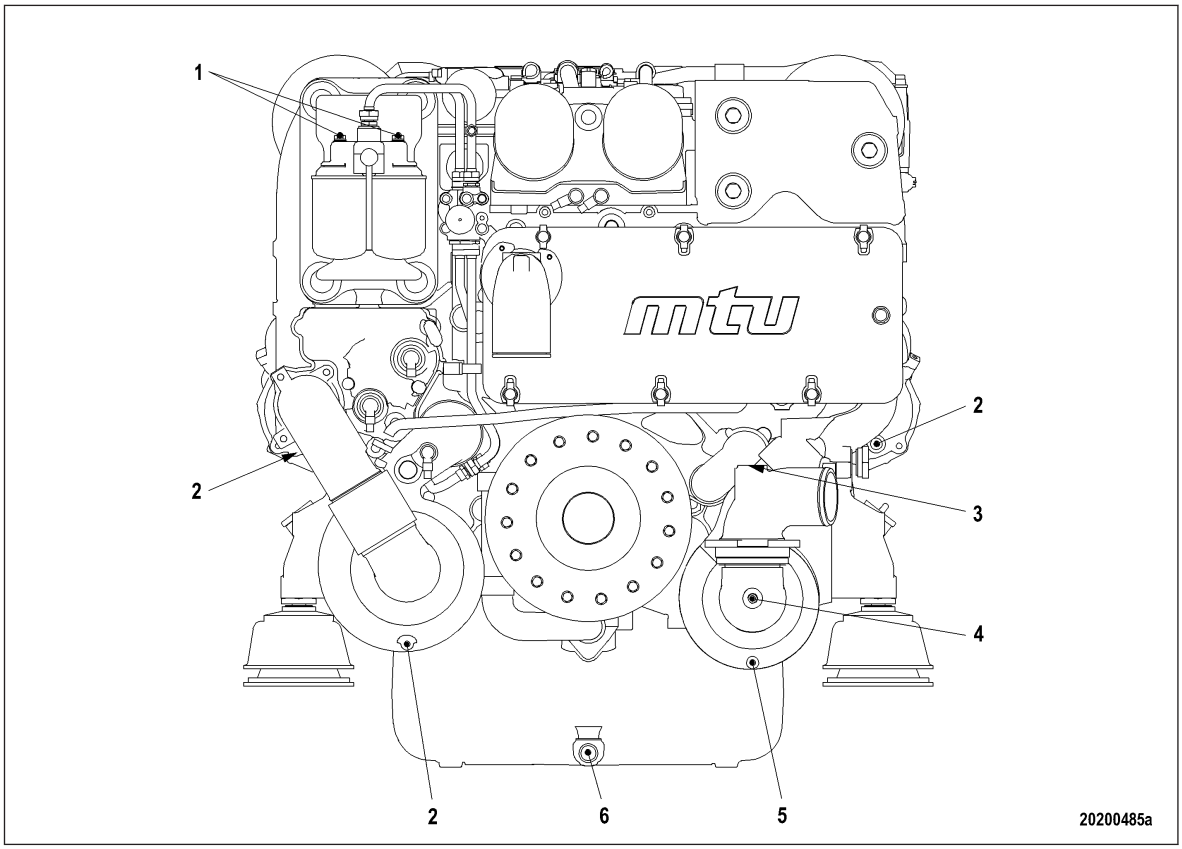



1 Overflow line, expansion tank

2 Filler neck

TIM-ID: 0000006696 - 001

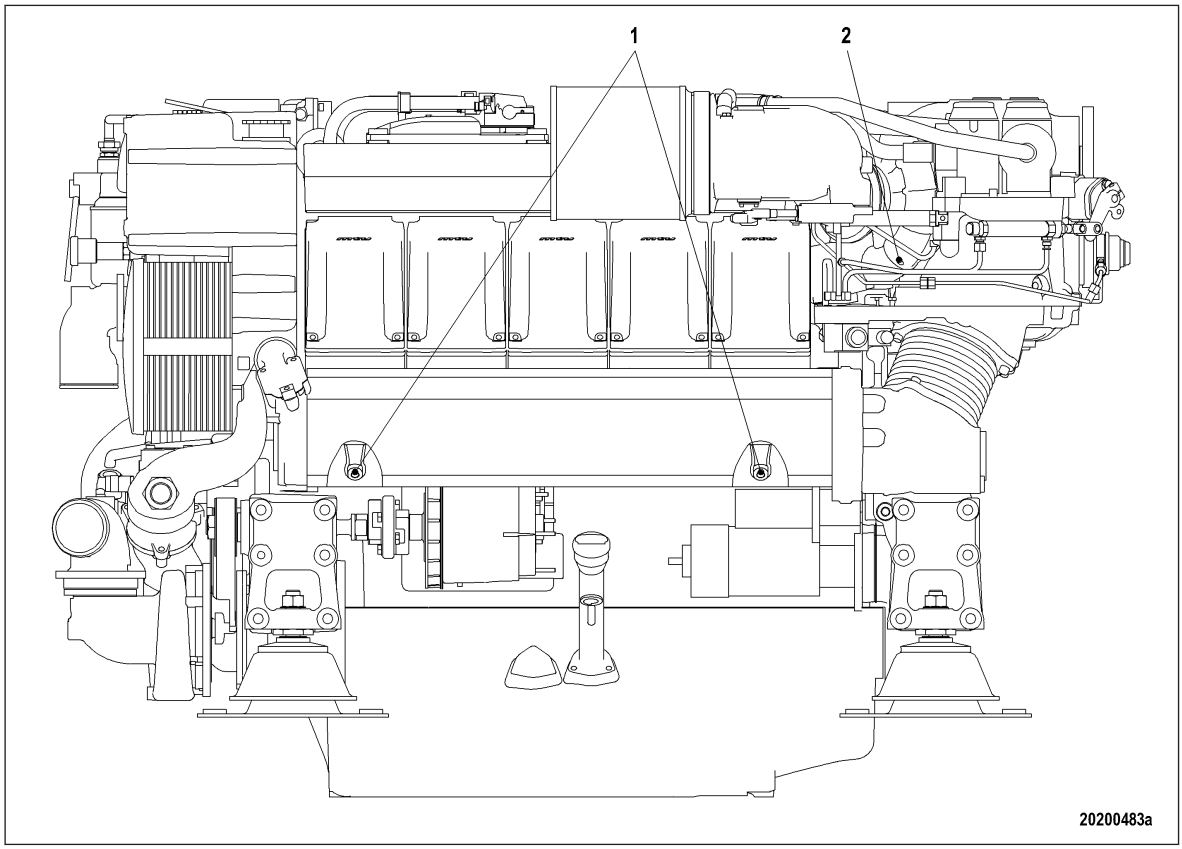
## Free end (KGS)




1 Fuel filter vent screws
2 Engine coolant drain plug
3 Raw water pump filling plug
4 Measuring point, pressure before raw water pump
5 Raw water pump drain plug
6 Connection for oil extraction

TIM-ID: 0000006696 - 001

## Left side

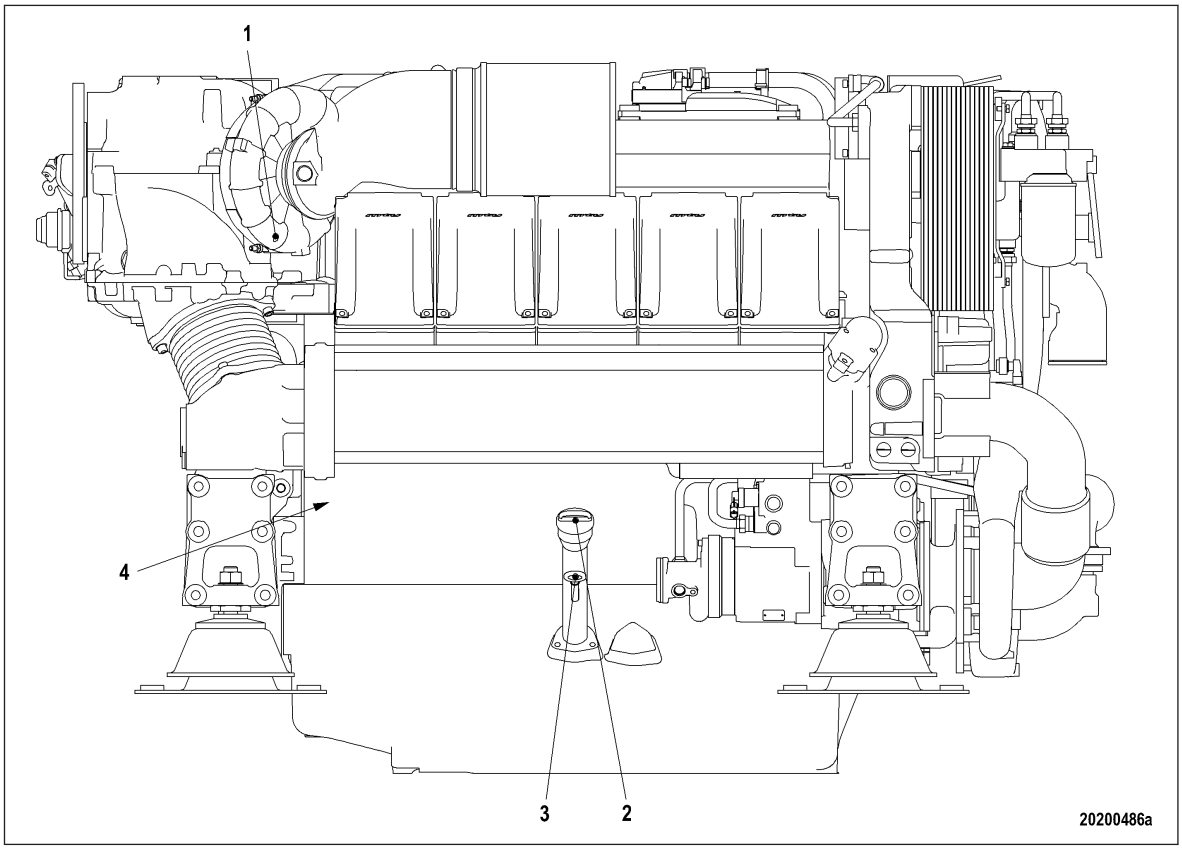



1 Engine coolant drain plug

2 Engine coolant drain plug (M14x1.5)

TIM-ID: 0000006696 - 001

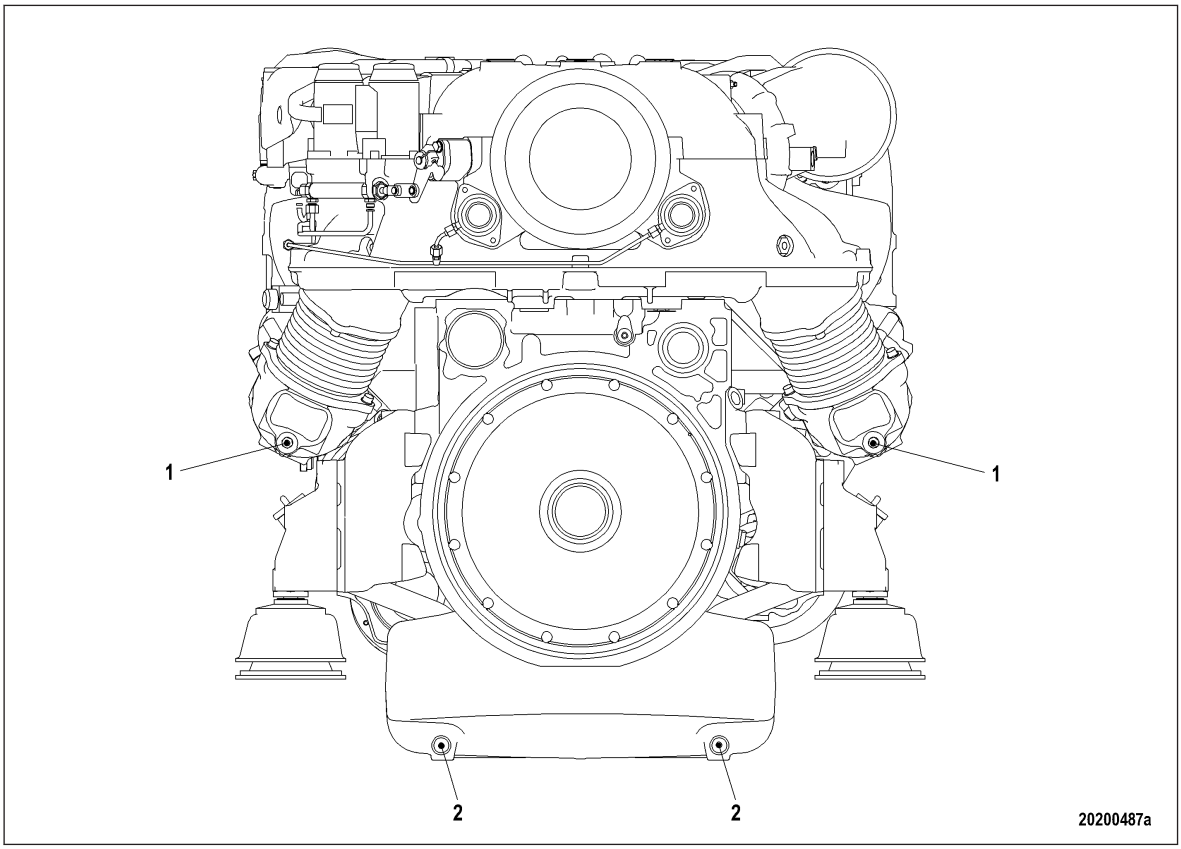
## Right side




1 Engine coolant drain plug (M14x1.5)
2 Oil filler neck (connection left or right engine side optional)
3 Oil dipstick (connection left or right engine side optional)
4 Leak-off-fuel tank

TIM-ID: 0000006696 - 001

## Driving end (KS)




1 Engine coolant drain plug

2 Connection for oil extraction

TIM-ID: 0000006696 - 001

## 7.15.2 Engine coolant – Level check

### Preconditions

☑ Engine is stopped and starting disabled.

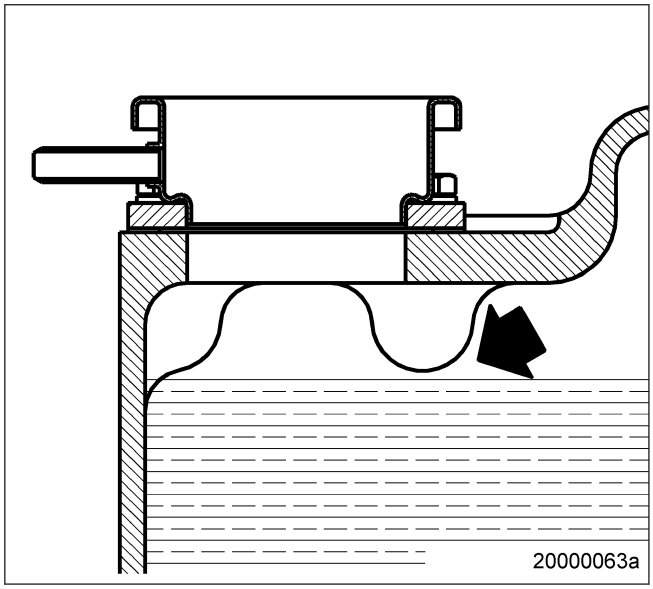
☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

WARNING

Coolant is hot and under pressure.
**Risk of injury and scalding!**
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Coolant-level check at filler neck:

1. Turn breather valve on coolant expansion tank (→ Page 25) counterclockwise until first stop and allow pressure to escape.
2. Continue to turn breather valve counter-clockwise and remove.
3. Check coolant level (coolant must be visible at the lower edge of the cast-in eye).




### Coolant-level check by means of level sensor:

1. Switch engine control system on and check display (coolant level is automatically monitored by the engine control system).
2. If required, top up with treated engine coolant (→ Page 118).

TIM-ID: 0000006765 - 001

## 7.15.3 Engine coolant – Change

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Engine coolant | | |

### Engine coolant – Change

1. Drain engine coolant (→ Page 117).
2. Fill with engine coolant (→ Page 118).

TIM-ID: 0000000036 - 028

## 7.15.4 Engine coolant – Draining

### Preconditions

☑ Engine is stopped and starting disabled.

WARNING

Coolant is hot and under pressure.
**Risk of injury and scalding!**
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Preparatory steps

1. Provide an appropriate container to collect the coolant or
2. switch on the extraction device.
3. Switch off preheating unit.

### Engine coolant – Draining

1. Turn breather valve on coolant expansion tank (→ Page 109)counterclockwise to the first stop and release pressure.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from the expansion tank through filler neck.
4. Open drain valves or drain plugs (→ Page 109) and drain or pump off coolant.
5. Close all open drain points.
6. Set breather valve onto filler neck and close it.

TIM-ID: 0000006746 - 001

## 7.15.5 Engine coolant – Filling

### Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specifications (A001061/..) are available.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Engine coolant | | |

**WARNING**

Coolant is hot and under pressure.
**Risk of injury and scalding!**
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

**CAUTION**

Cold coolant in hot engine can cause thermal stress.
**Formation of cracks in components!**
- Fill / top up coolant only into cold engine.

### Filling engine coolant

1. (→ Page 25)Turn breather valve of coolant expansion tank counterclockwise until the first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Pour coolant into engine until coolant level reaches lower edge of cast-in eye of filler neck.
4. Check proper condition of breather valve and clean sealing faces.
5. Place breather valve on filler neck and close.
6. Start the engine and operate it at idle speed for some minutes.
7. Check coolant level (→ Page 115).

TIM-ID: 0000006728 - 002

## 7.15.6 HT coolant pump — Relief bore check

**DANGER**

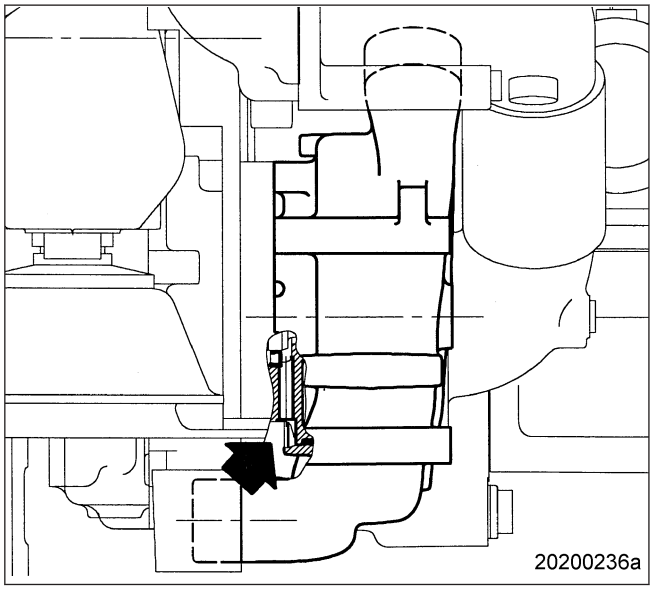
Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### HT coolant pump — Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Operating instructions electronic system) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible engine coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.




TIM-ID: 0000006803 - 002

## 7.15.7 Engine coolant – Sample extraction and analysis

### Preconditions

☑ Engine is stopped and starting disabled.

☑ MTU Fluids and Lubricants Specification (A001061/..) is available.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| MTU test kit | 5605892099/00 | 1 |

WARNING

Coolant is hot and under pressure.
**Risk of injury and scalding!**
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Engine coolant – Sample extraction and analysis

1. Turn breather valve on coolant expansion tank (→ Page 109)counterclockwise until first stop and allow pressure to escape.
2. Continue to turn breather valve counterclockwise and remove.
3. Draw off precipitated corrosion inhibitor oil from expansion tank and dispose of oil.
4. Draw off approx. 1 liter coolant and drain into a clean container.
5. Using the equipment and chemicals from the MTU test kit, examine coolant for:
   - antifreeze concentration;
   - corrosion inhibitor concentration;
   - pH value.
6. Fit breather valve and close it.
7. Change engine coolant according to the coolant operating times specified in the (→ MTU Fluids and Lubricants Specifications A001061/..)(→ Page 117).

TIM-ID: 0000006774 - 001

## 7.15.8 Coolant filter – Replacement

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

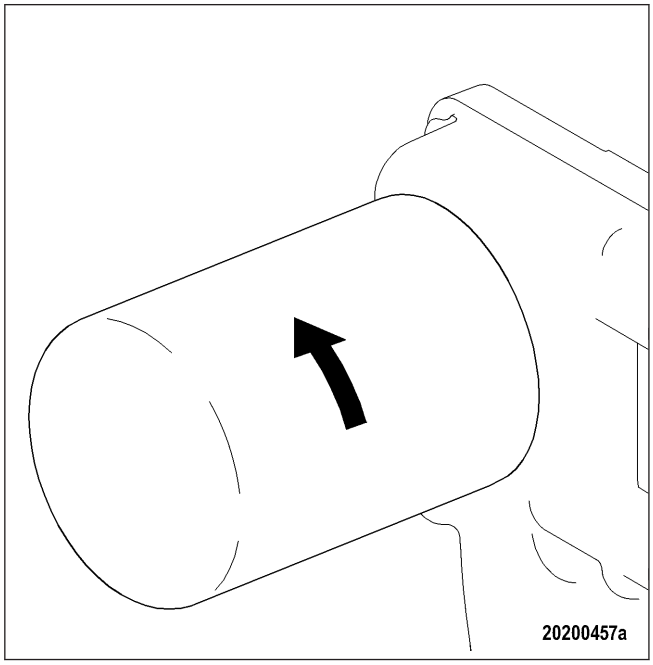
| Designation / Use | Part No. | Qty. |
|---|---|---|
| Oil filter wrench | F30379104 | 1 |
| Coolant filter | (→ Spare Parts Catalog) | |

WARNING

Coolant is hot and under pressure.
**Risk of injury and scalding!**
- Let the engine cool down.
- Wear protective clothing, gloves, and goggles / safety mask.

### Coolant filter – Replacement

1. Turn breather valve of coolant expansion tank counterclockwise (→ Page 25) to the first stop and allow pressure to escape.
2. Continue to turn breather valve counter-clockwise and remove.
3. Remove coolant filter using the oil filter wrench.
4. Clean the sealing face on the adapter.
5. Coat sealing ring of the new coolant filter with engine oil.
6. Install and tighten coolant filter by hand.
7. Close breather valve.
8. Check coolant level (→ Page 115).




TIM-ID: 0000006921 - 004

# 7.16 Raw Water Pump with Connections

## 7.16.1 Raw water pump – Relief bore check

**DANGER**

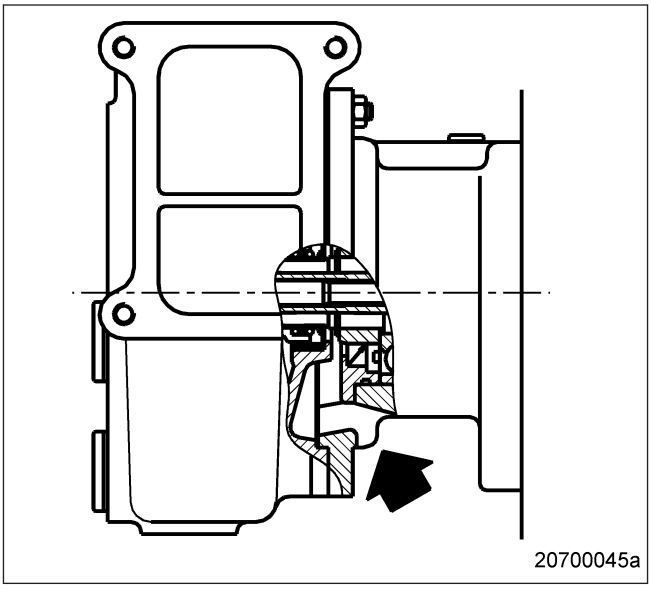
Unguarded rotating and moving engine components.
**Risk of serious injury – danger to life!**
- Take special care when working on a running engine.

**WARNING**

Engine noise above 85 dB (A).
**Risk of damage to hearing!**
- Wear ear protectors.

### Raw water pump – Relief bore check

1. Check relief bore for oil and coolant discharge.
2. Stop engine (→ Page 55) and disable engine start.
3. Clean the relief bore with a wire if it is dirty.
   - Permissible coolant discharge: up to 10 drops per hour;
   - Permissible oil discharge: up to 5 drops per hour.
4. If discharge exceeds the specified limits, contact Service.




TIM-ID: 0000007284 - 001

# 7.17 Belt Drive

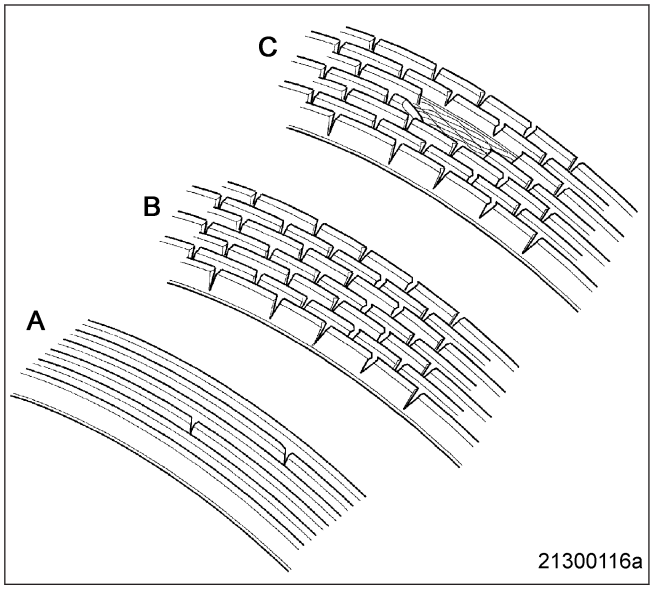
## 7.17.1 Drive belt – Condition check

### Preconditions

☑ Engine is stopped and starting disabled.

☑ Guard is removed.

### Drive belt – Condition check




| Item | Findings | Action |
|---|---|---|
| Drive belt A | Singular cracks | None |
| Drive belt | Belt is oily, shows signs of over-heating | Replace(→ Page 124) |
| Drive belt B | Cracks on entire circumference | |
| Drive belt C | Chunking | |

TIM-ID: 0000000920 - 009

# 7.18 Battery-Charging Generator

## 7.18.1 Battery-charging generator drive – Drive belt replacement

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Mandrel | 8205892861/08 | 1 |

### Preparatory steps

1. Remove safety equipment (if fitted).
2. Remove screws of protective cover (engine free end).
3. Remove protective cover.

### Drive belt – Replacement

1. Hold adjusting lever at square.
2. Rotate adjusting lever until drive belt is released.
3. Use mandrel to lock adjusting lever in position.
4. Remove drive belt.
5. Check cleanness of belt pulleys.
6. Fit new drive belt.
7. Remove mandrel.

### Final steps

1. Install protective cover.
2. Install screws of protective cover.
3. Install safety equipment (if fitted).
4. Check function of safety equipment (if fitted).

TIM-ID: 0000007424 - 003

# 7.19 Fuel Treatment System

## 7.19.1 Water drain valve – Check

### Checking water drain valve

1. Open water drain valve.
2. Check water outlet for obstructions.
3. Close water drain valve.

TIM-ID: 0000007733 - 006

## 7.19.2 Differential pressure gauge – Check

WARNING

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Checking differential pressure gauge

1. Switch on fuel treatment system (→ Page 53).
2. Set the alarm points at the differential pressure gauge to zero.

Result: Alarm is initiated with preset delay.

3. Reset the alarm points at the differential pressure gauge to the specified values.

TIM-ID: 0000007737 - 005

## 7.19.3 Water level probe (3-in-1 rod electrode) – Check

### Preconditions

☑ System is put out of service and emptied.

WARNING

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Water level probe (3-in-1 rod electrode) – Check

1. Disconnect plug from water level probe.
2. Unscrew water level probe.
3. Disconnect plug from water level probe.
4. Immerse water level probe into a tank filled with water until water level reaches the thread.

Result: Water drain valve opens.

5. Leave water level probe in tank.

Result: Alarm must be triggered with the preset delay.

6. Disconnect plug from water level probe.
7. Remove water level probe from tank.
8. Screw in water level probe.
9. Connect plug for water level probe.
10. Put the fuel treatment system into operation.

TIM-ID: 0000007739 - 006

## 7.19.4 Pump capacity – Check

WARNING

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

### Checking pump capacity

1. Install suitable pressure gauge at the neck of the intake side of the pump.
2. Check pump pressure.
   a) Switch on fuel treatment system (→ Page 53).

Note: The pressure limiting valve at the pump might respond and open. Audible noise is caused by overflowing fuel and can be disregarded.

   b) Close ball valve at the outlet of the fuel treatment system.
   c) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note it.
3. Check pump pressure with reduced suction.
   a) Reduce suction pressure of pump to -0.8 bar with the shutoff valve at the pump intake side.
   b) Check pressure at the pressure gauge in the inlet to the fuel treatment system and note it.
   c) Open ball valve at inlet and outlet of fuel treatment system.
4. Calculate wear limit.

| Example: | |
|---|---|
| Measured value (normal condition). | 3 bar |
| Measured value (reduced suction condition). | 2.6 bar |
| If the measured value (reduced suction condition) is 10% lower than the measured value (normal condition), the wear limit is reached. Repair pump (contact Service). | |

TIM-ID: 0000007740 - 007

## 7.19.5 Coalescer filter element – Replacement

### Preconditions

☑ System is switched off and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Torque wrench, 6-50 Nm | F30027336 | 1 |
| Ratchet adapter | F30027339 | 1 |
| Diesel fuel | | |
| Engine oil | | |
| Coalescer filter element | (→ Spare Parts Catalog) | |
| Gasket | (→ Spare Parts Catalog) | |

**WARNING**

Fuels are combustible.
**Risk of fire and explosion!**
- Avoid open flames, electrical sparks and ignition sources.
- Do not smoke.

**CAUTION**

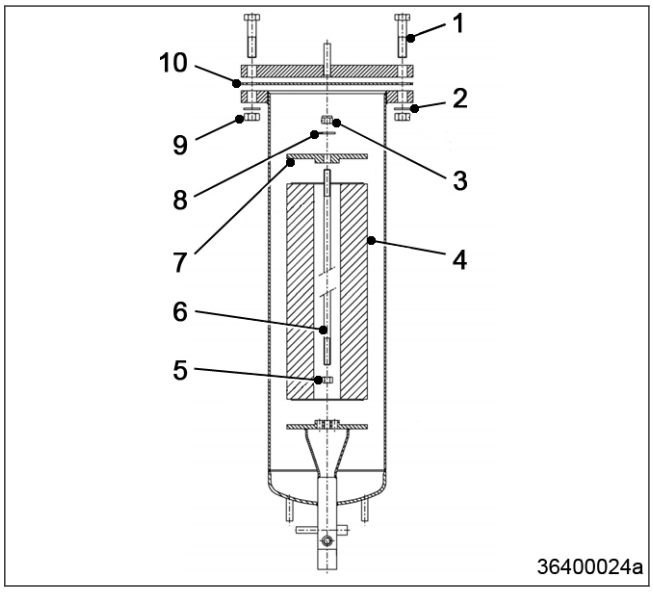
Contamination of components.
**Damage to component!**
- Observe manufacturer's instructions.
- Check components for special cleanness.

**CAUTION**

Incorrect installation of components and lines.
**Damage to component!**
- Ensure that components/lines are installed so that they are never under tension or strain.
- Ensure correct installation position of components.

### Replacing coalescer filter element

1. Close ball valve at the inlet and outlet of the fuel treatment system.
2. Open drain valve.
3. Drain fuel.
4. Close drain valve.
5. Remove nut (9) with washer (2).
6. Remove screws (1).
7. Remove cover with gasket (10).
8. Remove nut (3), washer (8) and end plate (7).
9. Remove coalescer filter element (4).
10. Catch fuel as it runs out.
11. Clean housing with a non-linting cloth, rinse with fuel if required.
12. Check housing for corrosion.
13. Clean housing sealing surfaces.
14. Install coalescer filter element.
15. Install end plate (7), washer (8) and nut (3).




TIM-ID: 0000007735 - 006

16. Tighten nut (3) to specified tightening torque using a torque wrench.

| Name | Size | Type | Lubricant | Value/Standard |
|---|---|---|---|---|
| Nut | M16 | Tightening torque | (Engine oil) | 30 Nm +3 Nm |

17. Fit gasket (10).
18. Install cover.
19. Install screw (1), washer (2) and nut (9).
20. Tighten nut (9).
21. Open ball valve at the inlet and outlet of the fuel treatment system.

Result: The fuel treatment system is ready for operation.

TIM-ID: 0000007735 - 006

# 7.20 Wiring (General) for Engine/Gearbox/Unit

## 7.20.1 Engine wiring – Check

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Isopropyl alcohol | X00058037 | 1 |

### Engine wiring – Check

1. Check securing screws of cable clamps on engine and tighten loose threaded connections.
2. Ensure that cables are fixed in their clamps and cannot swing freely.
3. Check that cable ties are firm, tighten loose cable ties.
4. Replace faulty cable ties.
5. Visually inspect the following electrical line components for damage:
   - connector housings;
   - contacts;
   - sockets;
   - cables and terminals;
   - plug-in contacts.
6. (→ Contact Service) if cable conductors are damaged.

Note: Close male connectors that are not plugged in with the protective cap supplied.

7. Clean dirty connector housings, sockets and contacts with isopropyl alcohol.
8. Ensure that all sensor connectors are securely engaged.

TIM-ID: 0000000029 - 018

# 7.21 Accessories for (Electronic) Engine Governor / Control System

## 7.21.1 Engine governor and connectors – Cleaning

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Isopropyl alcohol | X00058037 | 1 |

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose.Otherwise the contacts could be bent.

### Engine governor and connectors – Cleaning

1. Remove coarse dirt from housing surface with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

### Cleaning severely contaminated connectors on the engine governor

Note: Seal unused connectors with the supplied protective cap.

1. Release the latch and pull off connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and lock them.

TIM-ID: 000000047 - 009

## 7.21.2 Engine governor – Checking plug-in connections

### Preconditions

☑ Engine is stopped and starting disabled.

Note: Always use test connectors to enter the connectors. Never use test leads for this purpose.Otherwise the contacts could be bent.

### Checking plug-in connections on engine governor

1. Check all plug-in connections for secure seating.
2. Latch connectors if loose.

TIM-ID: 0000000048 - 005

## 7.21.3 EMU – Checking plug-in connections

### Preconditions

☑ Engine is stopped and starting disabled.

### EMU – checking plug-in connections

1. Verify that all plug-in connections are securely seated.
2. Secure loose connectors and latch.

TIM-ID: 0000008395 - 001

## 7.21.4 Engine governor – Carry out self-test

DANGER

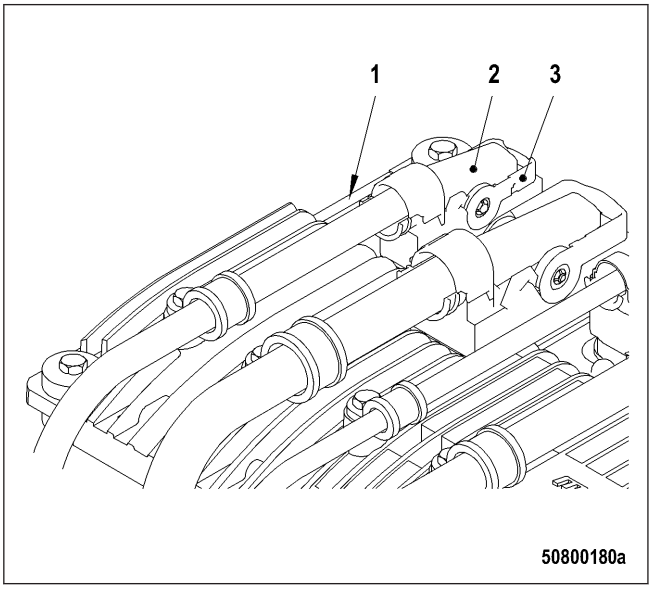
Electrical voltage.
**Risk of serious injury - danger to life!**
- Make certain that the power supply to the engine is switched off before starting to work. Ensure that the power supply cannot be switched on unintentionally!

### Carrying out self-test

1. Switch off power supply to system.
2. Remove connectors X1, X2 and X4 from the engine governor.
   a) Release lock (3) of connectors (2).
   b) Unplug connector (2).
3. Switch on power supply

Result:
- The engine governor is operable if the diagnostic lamp (1) changes to continuous illumination within 30 seconds after power has been switched on.
- If the diagnostic lamp (1) flashes after 30 seconds, replace engine governor and (→ contact Service).
- Check the power supply if the diagnostic lamp remains dark.

4. Switch off power supply.
5. Refit connectors X1, X2 and X4 on engine governor.
   a) Plug in connector (2).
   b) Lock connectors.




TIM-ID: 0000008482 - 002

## 7.21.5 EMU and connectors – Cleaning

### Preconditions

☑ Engine is stopped and starting disabled.

### Special tools, Material, Spare parts

| Designation / Use | Part No. | Qty. |
|---|---|---|
| Isopropyl alcohol | | |

### EMU and connectors – Cleaning

1. Remove coarse dirt from housing surface using a cloth moistened with isopropyl alcohol.
2. Remove dirt from connector and cable surfaces with isopropyl alcohol.
3. Check legibility of cable labels. Clean or replace illegible labels.

### Cleaning severely contaminated EMU connectors

1. Release latches of connectors and withdraw connectors.
2. Clean connector housings, connector socket housings and all contacts with isopropyl alcohol.
3. When connectors, sockets and all contacts are dry: Fit connectors and secure latches.

TIM-ID: 0000008392 - 001

## 7.21.6 ECU 7 engine governor – Removal and installation

### Preconditions

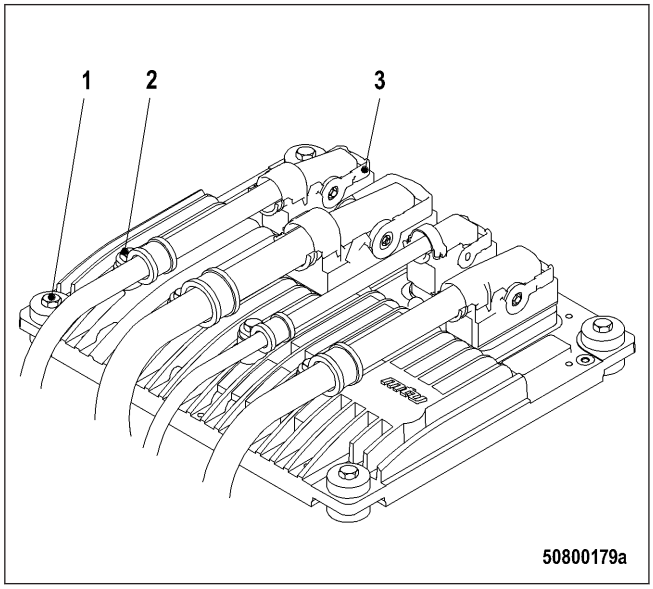
☑ Engine is stopped and starting disabled.

CAUTION

Wrong engine governor installed.
**Engine damage!**
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

### Removing engine governor from engine

1. Note or mark assignment of cables and connectors.
2. Remove all screws (2).
3. Undo latches (3) of the connectors.
4. Remove all connectors.
5. Remove screws (1).
6. Take off engine governor.




### Installing engine governor on engine

1. Install in reverse order. In doing so, ensure correct assignment of connectors and sockets.
2. Check rubber mount before installation.

Result: If the rubber mount is porous or defective, replace it.

TIM-ID: 0000000049 - 005

## 7.21.7 Engine monitoring unit – Removal and installation

### Preconditions

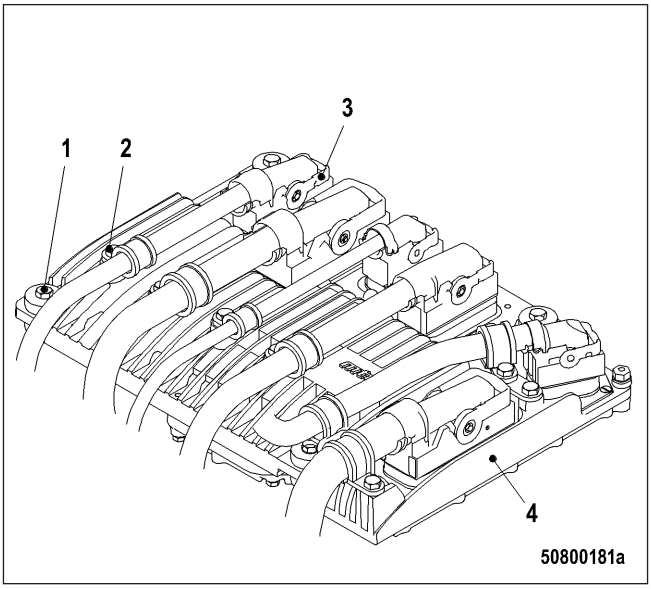
☑ Engine is stopped and starting disabled.

CAUTION

Wrong engine governor installed.
**Engine damage!**
- When reassembling an engine, make sure that the governor with the data record for the given engine is installed.

### Removing engine governor with engine monitoring unit from engine

1. Note or mark assignment of cables and plugs.
2. Remove all screws (2).
3. Release lock (3) of connectors..
4. Remove all connectors.
5. Remove screws (1).
6. Remove engine governor (1) with engine monitoring unit (4).




### Removing engine monitoring unit

1. Unscrew screws on base of EMU (4).
2. Remove EMU (4) with engine governor (1).

### Installing engine monitoring unit

1. Place EMU (4) in position at engine governor (1).
2. Screw in and tighten screws on base of EMU (4).

### Installing engine governor with engine monitoring unit on engine

1. Install in reverse order. Ensure correct assignment of plugs and sockets.
2. Check resilient mount before installing.

Result: If resilient mount is porous or defective then replace it.

TIM-ID: 0000008493 - 002

# 8 Appendix A

## 8.1 Abbreviations

| Abbreviation | Meaning | Explanation |
|---|---|---|
| ADEC | Advanced Diesel Engine Control | Engine governor |
| AL | Alarm | Alarm (general) |
| ANSI | American National Standards Institute | Association of American standardization organizations |
| ATL | Abgasturbolader | Exhaust turbocharger (ETC) |
| BR | Baureihe | Series |
| BV | Betriebsstoffvorschrift | MTU Fluids and Lubricants Specifications, Publication No. A01061/.. |
| CAN | Controller Area Network | Data bus system, bus standard |
| CCG | Cross Connection Gear | Transfer gearbox |
| CODAG | Combined Diesel (engine) And Gas (turbine propulsion) | |
| CPP | Controllable Pitch Propeller | |
| DAG | Diesel (engine) And Gas (turbine) | |
| DE | Diesel Engine | |
| DIN | Deutsches Institut für Normung e. V. | At the same time identifier of German standards (DIN = “Deutsche Industrie-Norm”) |
| DIS | Display unit | |
| DL | Default Lost | Alarm: CAN bus missing |
| ECS | Engine Control System | |
| ECS-UNI | Engine Control System UNIversal | |
| ECU | Engine Control Unit | Engine governor |
| EDM | Engine Data Module | |
| EMU | Engine Monitoring Unit | |
| ETK | Ersatzteilkatalog | Spare Parts Catalog (SPC) |
| FPP | Fixed Pitch Propeller | |
| GCU | Gear Control Unit | |
| GMU | Gear Monitoring Unit | |
| GT | Gas Turbine | |
| HAT | Harbor Acceptance Test | |
| HI | High | Alarm: Measured value exceeds 1st maximum limit |
| HIHI | High High | Alarm: Measured value exceeds 2nd maximum limit value |
| HT | High Temperature | |
| ICFN | ISO – Continuous rating – Fuel stop power – Net | Power specification in accordance with DIN-ISO 3046-7 |

TIM-ID: 0000002049 - 005

| Abbreviation | Meaning | Explanation |
|---|---|---|
| IDM | Interface Data Module | |
| IMO | International Maritime Organization | |
| ISO | International Organization for Standardization | International umbrella organization for all national standardization institutes |
| KGS | Kraftgegenseite | Engine free end in accordance with DIN ISO 1204 |
| KS | Kraftseite | Engine driving end in accordance with DIN ISO 1204 |
| LCD | Liquid Crystal Display, Liquid Crystal Device | |
| LCU | Local Control Unit | LOP subassembly |
| LED | Light Emitting Diode | |
| LMU | Local Monitoring Unit | LOP subassembly |
| LO | Low | Alarm: Measured value lower than 1st minimum limit value |
| LOLO | Low Low | Alarm: Measured value lower than 2nd minimum limit value |
| LOP | Local Operating Panel | Control console, control panel |
| LOS | Local Operating Station | |
| MCS | Monitoring and Control System | |
| MG | Message | |
| MPU | Microprocessor Unit, Microprocessing Unit | |
| MRG | Main Reduction Gear | |
| OT | Oberer Totpunkt | Top Dead Center (TDC) |
| P-xyz | Pressure-xyz | Pressure measuring point xyz |
| PAN | Panel | Control panel |
| PCU | Propeller Control Unit | |
| PIM | Peripheral Interface Module | |
| PT | Power Turbine | |
| RCS | Remote Control System | |
| RL | Redundancy Lost | Alarm: Redundant CAN bus missing |
| SAE | Society of Automotive Engineers | U.S. standardization organization |
| SAT | Sea Acceptance Test | |
| SD | Sensor Defect | Alarm: Sensor failure |
| SDAF | Shut Down Air Flaps | Emergency-air shutoff flap(s) |
| SOLAS | International Convention for the Safety of Life at Sea | |
| SS | Safety System | Safety system alarm |
| SSK | Schnellschlussklappe(n) | Emergency air shut-off flaps |
| SSS | Synchronized Self-Shifting (clutch) | |
| STBD | Starboard | |
| T-xyz | Temperature-xyz | Temperature measuring point xyz |

TIM-ID: 0000002049 - 005

| Abbrevia-tion | Meaning | Explanation |
|---|---|---|
| TD | Transmitter Deviation | Alarm: Deviation in transmitter values |
| UT | Unterer Totpunkt | Bottom Dead Center (BDC) |
| VS | Voith Schneider | Voith Schneider drive |
| WJ | Water jet | Water jet drive |
| WZK | Werkzeugkatalog | Tool Catalog (TC) |
| ZKP | Zugehörigkeit-Kategorie-Parameter | Assignment category parameter; number scheme for signals from the ADEC engine governor |

TIM-ID: 0000002049 - 005

## 8.2 MTU contacts/service partners

### Service

Our worldwide sales network with its subsidiaries, sales offices, representatives and customer service centers ensures fast and direct support on site and the high availability of our products.

### Local support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the MTU internet site: http://www.mtu-online.com

### 24h hotline

With our 24h hotline and the outstanding flexibility of our service staff, we are always ready to assist you - either during operation, for preventive maintenance, corrective work in case of malfunction or changed operating conditions, or for spare parts supply.

Your contact at Headquarters:Service-support@mtu-online.com

### Spare parts service

Fast, simple and correct identification of spare parts for your drive system or vehicle fleet. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked spares logistics system

- a central depot at Headquarters, as well as decentralized depots among our subsidiaries, representatives and contractual workshops.

Your contact at Headquarters:

E-mail: spare.parts@mtu-online.com

Phone: +49 7541 908555

Fax: +49 7541 908121

TIM-ID: 0000000873 - 012

# 9 Appendix B

## 9.1 Special Tools

| Alignment device | |
|---|---|
| Part No.: | F6790507 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Angular screw driver | |
|---|---|
| Part No.: | F30002816 |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Barring tool | |
|---|---|
| Part No.: | F6783914 |
| Qty.:<br>Used in: | 1<br>7.2.1 Engine – Barring manually (→ Page 72) |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Box wrench adapter | |
|---|---|
| Part No.: | F30451199 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Centering device | |
|---|---|
| Part No.: | F6783025 |
| Qty.:<br>Used in: | 1<br>7.5.2 Cylinder-head cover – Removal and installation (→ Page 84) |

| Double box wrench | |
|---|---|
| Part No.: | F30002800 |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Double box wrench | |
|---|---|
| Part No.: | F30011450 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Feeler gauge | |
|---|---|
| Part No.: | Y4345893 |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

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| Mandrel | |
|---|---|
| Part No.: | 8205892861/08 |
| Qty.:<br>Used in: | 1<br>7.18.1 Battery-charging generator drive – Drive belt replacement (→ Page 124) |

| MTU test kit | |
|---|---|
| Part No.: | 5605892099/00 |
| Qty.:<br>Used in: | 1<br>7.15.7 Engine coolant – Sample extraction and analysis (→ Page 120) |

| Oil filter wrench | |
|---|---|
| Part No.: | F30379104 |
| Qty.:<br>Used in: | 1<br>7.8.1 Fuel filter – Replacement (→ Page 89) |
| Qty.:<br>Used in: | 1<br>7.14.1 Engine oil filter – Replacement (→ Page 104) |
| Qty.:<br>Used in: | 1<br>7.15.8 Coolant filter – Replacement (→ Page 121) |

| Open end wrench bit | |
|---|---|
| Part No.: | F30025897 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Puller | |
|---|---|
| Part No.: | F6790629 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Ratchet | |
|---|---|
| Part No.: | F30006212 |
| Qty.:<br>Used in: | 1<br>7.2.1 Engine – Barring manually (→ Page 72) |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Ratchet adapter | |
|---|---|
| Part No.: | F30027340 |
| Qty.:<br>Used in: | 1<br>7.4.2 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 79) |

| Ratchet adapter | |
|---|---|
| Part No.: | F30027339 |
| Qty.:<br>Used in: | 1<br>7.19.5 Coalescer filter element – Replacement (→ Page 129) |

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| Rigid endoscope | |
|---|---|
| Part No.: | Y20097353 |
| Qty.:<br>Used in: | 1<br>7.3.1 Cylinder liner – Endoscopic examination (→ Page 74) |

| Socket wrench | |
|---|---|
| Part No.: | F30030450 |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Socket wrench | |
|---|---|
| Part No.: | 0005896803/00 |
| Qty.:<br>Used in: | 1<br>7.6.2 Injector – Removal and installation (→ Page 86) |

| Steam jet cleaner | |
|---|---|
| Part No.: | - |
| Qty.:<br>Used in: | 1<br>4.13 Plant – Cleaning (→ Page 59) |

| Strap wrench | |
|---|---|
| Part No.: | F30379104 |
| Qty.:<br>Used in: | 1<br>7.14.2 Centrifugal oil filter – Cleaning and filter sleeve replacement (→ Page 106) |

| Torque wrench, 10-60 Nm | |
|---|---|
| Part No.: | F30510423 |
| Qty.:<br>Used in: | 1<br>7.5.1 Valve clearance – Check and adjustment (→ Page 81) |

| Torque wrench, 6-50 Nm | |
|---|---|
| Part No.: | F30027336 |
| Qty.:<br>Used in: | 1<br>7.4.2 Crankcase breather – Oil separator replacement, diaphragm check and replacement (→ Page 79) |
| Qty.:<br>Used in: | 1<br>7.19.5 Coalescer filter element – Replacement (→ Page 129) |

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